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Part V

Environmental Protection Agency

Automobile and Light-Duty Truck Surface Coating Operations; Standards of Performance and Addition to the List of Categories of Stationary Sources

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 60

[FRL-1285-4]

Automobile and Light-Duty Truck Surface Coating Operations; Standards of Performance

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: Standards of performance are proposed to limit emissions of volatile organic compounds (VOC) from new, modified, and reconstructed automobile and light-duty truck surface coating operations within assembly plants. Three new test methods are also proposed. Reference Method 24 (Candidate 1 or Candidate 2) would be used to determine the VOC content of coating materials, and Reference Method 25 would be used to determine the percentage reduction of VOC emissions achieved by add-on emission control devices.

The standards implement the Clean Air Act and are based on the Administrator's determination that automobile and light-duty truck surface coating operations within assembly plants contribute significantly to air pollution. The intent is to require new, modified, and reconstructed automobile and light-duty truck surface coating operations to use the best demonstrated system of continuous emission reduction, considering costs, nonair quality health, and environmental and energy impacts.

A public hearing will be held to provide interested persons an opportunity for oral presentation of data, views, or arguments concerning the proposed standards.

DATES: *Comments.* Comments must be received on or before December 14, 1979.

Public Hearing. The public hearing will be held on November 9, 1979, at 9 a.m.

Request to Speak at Hearing. Persons wishing to present oral testimony should contact EPA by November 2, 1979

ADDRESSES: *Comments.* Comments should be submitted to: Central Docket Section (A-130), Attention: Docket Number A-79-05, U.S. Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460.

Public Hearing. The public hearing will be held at National Environmental Resource Center (NERC), Rm. B-102, R.T.P., N.C. Persons wishing to present oral testimony should notify Ms. Shirley Tabler, Emission Standards and Engineering Division (MD-13), Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-5421.

Background Information Document. The Background Information Document (BID) for the proposed standards may be obtained from the U.S. EPA Library (MD-35), Research Triangle Park, North Carolina 27711, telephone number (919) 541-2777. Please refer to "Automobile and Light-Duty Truck Surface Coating Operations—Background Information for Proposed Standards," EPA-450/3-79-030.

Docket. The Docket, number A-79-05, is available for public inspection and copying at the EPA's Central Docket Section, Room 2903 B, Waterside Mall, Washington, D.C. 20460.

FOR FURTHER INFORMATION CONTACT: Mr. Don R. Goodwin, Director, Emission Standards and Engineering Division (MD-13), Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-5271.

SUPPLEMENTARY INFORMATION:

Proposed Standards

The proposed standards would apply to new automobile and light-duty truck surface coating operations. Existing plants would not be covered unless they undergo modifications resulting in increased emissions or reconstructions. The proposed standards would apply to each prime coat operation, each guide coat operation, and each topcoat operation within an assembly plant. Emissions of VOC from each of these operations would be limited as follows: 0.10 kilogram of VOC (measured as mass of carbon) per liter of applied coating solids from prime coat operations, 0.84 kilogram of VOC (measured as mass of carbon) per liter applied coating solids from guide coat operations, 0.84 kilogram of VOC (measured as mass of carbon) per liter of applied coating solids from topcoat operations.

These proposed emission limits are based on Method 24 (Candidate 1) which determines VOC content of coatings expressed as the mass of carbon. At the time the standards were developed, it was believed that VOC emissions should be determined from carbon measurements. Method 24 (Candidate 1) was developed to measure carbon directly and thus improve the accuracy of the previously used ASTM procedure D 2369-73, which measures the mass of volatile organics indirectly. However, questions have been raised concerning the validity of using the carbon method since the ratio of mass of carbon to mass of VOC in solvents used in automotive coatings varies over a wide range. The effect which this variation might have on the standards is still being investigated. Method 24 (Candidate 2) was developed as a test method for determining VOC emissions from coating materials in terms of mass of volatile organics and is also derived from ASTM procedure D 2369-73. The proposed emission limits, based on Method 24 (Candidate 2) which measures volatile organics, are: 0.16 kilogram of VOC per liter of applied coating solids from prime coat operations, and 1.36 kilogram of VOC per liter of applied coating solids for guide coat operations, and 1.36 kilogram of VOC per liter of applied coating solids from top coat operations. In order to provide an opportunity for public comment on both test methods, both are being proposed, and the final selection of a test method will be made before promulgation, based on the comments received.

Although the emission limits are based on the use of water-based coating materials in each coating operation, they can also be met with solvent-based coating materials through the use of other control techniques, such as incineration. Exemptions are included in the proposed standards which specifically exclude annual model changeovers from consideration as modifications.

Summary of Environmental, Energy, and Economic Impacts

Environmental, energy, and economic impacts of standards of performance are normally expressed as incremental differences between the impacts from a facility complying with the proposed standard and those for one complying with a typical State Implementation Plan (SIP) emission standard. In the case of automobile and light-duty truck surface coating operations, the incremental differences will depend on the control levels that will be required by revised SIP's. Revisions to most SIP's are currently in progress.

Most existing automobile and light-duty truck surface coating operations are located in areas which are considered nonattainment areas for purposes of achieving the National Ambient Air Quality Standard (NAAQS) for ozone. New facilities are expected to locate in similar areas. States are in the process of revising their SIP's for these areas and are expected to include revised emission limitations for automobile and light-duty truck surface coating operations in their new SIP's. In

revising their SIP's the States are relying on the control techniques guideline document, "Control of Volatile Organic Emissions from Existing Stationary Sources—Volume II: Surface Coating of Cans, Coil, Paper, Fabrics, Automobiles and Light-Duty Trucks" (EPA–450/2–77–088 [CTG]).

Since control technique guidelines are not binding, States may establish emission limits which differ from the guidelines. To the extent States adopt the emission limits recommended in the control techniques guideline document as the basis for their revised SIP's, the proposed standards of performance would have little environmental, energy, or economic impacts. The actual incremental impacts of the proposed standards of performance, therefore, will be determined by the final emission limitations adopted by the States in their revised SIP's. For the purpose of this rulemaking, however, the environmental, energy, and economic impacts of the proposed standards have been estimated based on emission limits contained in existing SIP's.

In addition to achieving further reductions in emissions beyond those required by a typical SIP, standards of performance have other benefits. They establish a degree of national uniformity to avoid situations in which some States may attract industries by relaxing air pollution standards relative to other States. Further, standards of performance improve the efficiency of case-by-case determinations of best available control technology (BACT) for facilities located in attainment areas, and lowest achievable emission rates (LAER) for facilities located in nonattainment areas, by providing a starting point for the basis of these determinations. This results from the process for developing a standard of performance, which involves a comprehensive analysis of alternative emission control technologies and an evaluation and verification of emission test methods. Detailed cost and economic analyses of various regulatory alternatives are presented in the supporting documents for standards of performance.

Based on emission control levels contained in existing SIP's, the proposed standards of performance would reduce emissions of VOC from new, modified, or reconstructed automobile and light-duty truck surface coating operations by about 80 percent. National emissions of VOC would be reduced by about 4,800 metric tons per year by 1983.

Water pollution impacts of the proposed standards would be relatively small compared to the volume and quality of the wastewater discharged from plants meeting existing SIP levels. The proposed standards are based on the use of water-based coating materials. These materials would lead to a slight increase in the chemical oxygen demand (COD) of the wastewater discharged from the surface coating operations within assembly plants. This increase in COD, however, is not great enough to require additional wastewater treatment capacity beyond that required in existing assembly plants using solvent-based surface coating materials.

The solid waste impact of the proposed standards would be negligible compared to the amount of solid waste generated by existing assembly plants. The solid waste generated by water-based coatings, however, is very sticky, and equipment cleanup is more time consuming than for solvent-based coatings. Solid wastes from water-based coatings do not present any special disposal problems since they can be disposed of by conventional landfill procedures.

National energy consumption would be increased by the use of water-based coatings to comply with the proposed standards. The equivalent of an additional 18,000 barrels of fuel oil would be consumed per year at a typical assembly plant. This is equivalent to an increase of about 25 percent in the energy consumption of a typical surface coating operation. National energy consumption would be increased by the equivalent of about 72,000 barrels of fuel oil per year in 1983. This increase is based on the projection that four new assembly plants will be built by 1983.

The proposed standards would increase the capital and annualized costs of new automobile and light-duty truck surface coating operations within assembly plants. Capital costs for the four new facilities planned by 1983 would be increased by approximately $19 million as a result of the proposed standards. The incremental capital costs for control represent about 0.2 percent of the $10 billion planned for capital expenditures. The corresponding annualized costs would be increased by approximately $9 million in 1983. The price of an automobile or light-duty truck manufactured at a new plant which complies with the proposed standards of performance would be increased by less than 1 percent. This is considered to be a reasonable control cost.

Modifications and Reconstructions

During the development of the proposed standards, the automobile industry expressed concern that changes to assembly plants made only for the purpose of annual model changeovers would be considered a modification or reconstruction as defined in the Code of Federal Regulations, Title 40, Parts 60.14 and 60.15 (40 CFR 60.14 and 60.15). A modification is any physical or operational change in an existing facility which increases air pollution from that facility. A reconstruction is any replacement of components of an existing facility which is so extensive that the capital cost of the new components exceeds 50 percent of the capital cost of a new facility. In general, modified and reconstructed facilities must comply with standards of performance. According to the available information, changes to coating lines for annual model changeovers do not cause emissions to increase significantly. Further, these changes would normally not require a capital expenditure that exceeds the 50 percent criterion for reconstruction. Hence, it is very unlikely that these annual facility changes would be considered either modifications or reconstructions. Therefore, the proposed standards state that changes to surface coating operations made only to accommodate annual model changeovers are not modifications or reconstructions. In addition, by exempting annual model changeovers, enforcement efforts are greatly reduced with little or no adverse environmental impact.

Selection of Source and Pollutants

VOC are organic compounds which participate in atmospheric photochemical reactions or are measured by Reference Methods 24 (Candidate 1 or Candidate 2) and 25. There has been some confusion in the past with the use of the term "hydrocarbons." In addition to being used in the most literal sense, the term "hydrocarbons" has been used to refer collectively to all organic chemicals. Some organics which are photochemical oxidant precursors are not hydrocarbons (in the strictest definition) and are not always used as solvents. For purposes of this discussion, organic compounds include all compounds of carbon except carbonates, metallic carbides, carbon monoxide, carbon dioxide and carbonic acid.

Ozone and other photochemical oxidants result in a variety of adverse impacts on health and welfare, inducing impaired respiratory function, eye irritation, deterioration of materials such as rubber, and necrosis of plant tissue. Further information on these effects can be found in the April 1978 EPA document "Air Quality Criteria for Ozone and Other Photochemical Oxidants," EPA–600/8–78–004. This

document can be obtained from the EPA library (see Addresses Section).

Industrial coating operations are a major source of air pollution emissions of VOC. Most coatings contain organic solvents which evaporate upon drying of the coating, resulting in the emission of VOC. Among the largest individual operations producing VOC emissions in the industrial coating category are automobile and light-duty truck surface coating operations. Since the surface coating operations for automobiles and light-duty trucks are very similar in nature, with line speed being the primary difference, they are being considered together in this study. Automobile and light-duty truck manufacturers employ a variety of surface coatings, most often enamels and lacquers, to produce the protective and decorative finishes of their product. These coatings normally use an organic solvent base, which is released upon drying.

The "Priority List for New Source Performance Standards under the Clean Air Act Amendments of 1977," which was promulgated in 40 CFR 60.16, 44 FR 49222, dated August 21, 1979, ranked sources according to the impact that standards promulgated in 1980 would have on emissions in 1990. Automobile and light-duty truck surface coating operations rank 27 out of 59 on this list of sources to be controlled.

The surface coating operation is an integral part of an automobile or light-duty truck assembly plant, accounting for about one-quarter to one-third of the total space occupied by a typical assembly plant. Surface coatings are applied in two main steps, prime coat and topcoat. Prime coats may be water-based or organic solvent-based. Water-based coatings use water as the main carrier for the coating solids, although these coatings normally contain a small amount of organic solvent. Solvent-based coatings use organic solvent as the coating solids carrier. Currently about half of the domestic automobile and light-duty truck assembly plants use water-based prime coats.

Where water-based prime coating is used, it is usually applied by EDP. The EDP coat is normally followed by a "guide coat," which provides a suitable surface for application of the topcoat. The guide coat may be water-based or solvent-based.

Automobile and light-duty truck topcoats presently being used are almost entirely solvent-based. One or more applications of topcoats are applied to ensure sufficient coating thinkness. An oven bake may follow each topcoat application, or the coating may be applied wet on wet.

In 1976, nationwide emissions of VOC from automobile and light-duty truck surface coating operations totaled about 135,000 metric tons. Prime and guide coat operations accounted for about 50,000 metric tons with the remaining 85,000 metric tons being emitted from topcoat operations. This represents almost 15 percent of the volative organic emissions from all industrial coating operations.

VOC comprise the major air pollutant emmitted by automobile and light-duty truck assembly plants. Technology is available to reduce VOC emissions and thereby reduce the formation of ozone and other photochemical oxidants. Consequently, automobile and light-duty truck surface coating operations have been selected for the development of standards of performance.

Selection of Affected Facilities

The prime coat, guide coat, and topcoat operations usually account for more than 80 percent of the VOC emissions from autombile and light-duty truck assembly plants. The remaining VOC emissions result from final topcoat repair, cleanup, and coating of various small component parts. These VOC emission sources are much more difficult to control than the main surface coating operations for several reasons. First, water-based coatings cannot be used for final topcoat repair, since the high temperatures required to cure water-based coatings may damage heat sensitive components which have been attached to the vehicle by this stage of production. Second, the use of solvents is required for equipment cleanup procedures. Third, add-on controls, such as incineration, cannot be used effectively on these cleanup operations because they are composed of numerous small operations located throughout the plant. Since prime coat, guide coat, and topcoat operations account for the bulk of VOC emissions from autombile and light-duty truck assembly plants, and control techniques for reducing VOC emissions from these operations are demonstrated, they have been selected for control by standards of performance.

The "affected facility" to which the proposed standards would apply could be designated as the entire surface coating line or each individual surface coating operation. A major consideration in selecting the affected facility was the potential effect that the modification and reconstruction provisions under 40 CFR 60.14 and 60.15, which apply to all standards of performance, could have on existing assembly plants. A modification is any physical or operational change in an existing facility which increases air pollution from that facility. A reconstruction is any replacement of components of an existing facility which is so extensive that the capital cost of the new componensts exceeds 50 percent of the capital cost of a new facility. For standards of performance to apply, EPA must conclude that it is technically and economically feasible for the reconstructed facility to meet the standards.

Many automobile and light-duty truck assembly plants that have a spray prime coat system will be switching to EDP prime coat systems in the future to reduce VOC emissions to comply with revised SIP's. The capital cost of this change could be greater than 50 percent of the capital cost of a new surface coating line. If the surface coating line were chosen as the affected facility, and if this switch to an EDP prime coat system were considered a reconstruction of the surface coating line, all surface coating operations on the line would be required to comply with the proposed standards. Most plants would be reluctant to install an EDP prime coat system to reduce VOC emissions if, by doing so, the entire surface coating line might then be required to comply with standards of performance. By designating the prime coat, guide coat, and topcoat operations as separate affected facilities, this potential problem is avoided. Thus, each surface coating operation (i.e., prime coat, guide coat, and topcoat) has been selected as an affected facility in the proposed standards.

Selection of Best System of Emission Reduction

VOC emissions from automobile and light-duty truck surface coating operations can be controlled by the use of coatings having a low organic solvent content, add-on emissions control devices, or a combination of the two. Low organic solvent coatings consist of water-based enamels, high solids enamels, and powder coatings. Add-on emission control devices consist of such techniques as incineration and carbon adsorption.

Control Technologies

Water-based coating materials are applied either by conventional spraying or by EDP. Application of coatings by EDP involves dipping the automobile or truck to be coated into a bath containing a dilute water solution of the coating material. When charges of opposite polarity are applied to the dip tank and vehicle, the coating material deposits on the vehicle. Most EDP systems presently in use are anodic systems in which the vehicle is given a positive charge.

Cathodic EDP, in which the vehicle is negatively charged, is a new technology which is expanding rapidly in the automotive industry. Cathodic EDP provides better corrosion resistance and requires lower cure temperatures than anodic systems. Cathodic EDP systems are also capable of applying better coverage on deep recesses of parts.

The prime coat is usually followed by a spray application of an intermediate coat, or guide coat, before topcoat application. The guide coat provides the added film thickness necessary for sanding and a suitable surface for topcoat application. EDP can only be used if the total film thickness on the metal surface does not exceed a limiting value. Since this limiting thickness is about the same as the thickness of the prime coat, spraying has to be used for guide coat and topcoat application of water-based coatings.

Currently, nearly half of domestic automobile and light-duty truck assembly plants use EDP for prime coat application, but only two domestic plants use water-based coating for guide coat and topcoat applications.

Coatings whose solids content is about 45 to 60 percent are being developed by a number of companies. When these coatings are applied at high transfer efficiency rates, VOC emissions are significantly less than emissions from existing solvent-based systems. While these high solids coatings could be used in the automotive industry, certain problems must be overcome. The high working viscosity of these coatings makes them unsuitable for use in many existing application devices. In addition, this high viscosity can produce an "orange peel," or uneven, surface. It also makes these coatings unsuitable for use with metallic finishes. Metallic finishes, which account for about 50 percent of domestic demand, are produced by adding small metal flakes to the paint. As the paint dries, these flakes become oriented parallel to the surface. With high solids coatings, the viscosity of the paint prevents movement of the flakes, and they remain randomly oriented, producing a rough surface. However, techniques such as heated application are being investigated to reduce these problems, and it is expected that by 1982 high solids coatings will be considered technically demonstrated for use in the automotive industry.

Powder coatings are a special class of high solids coatings that consist of solids only. They are applied by electrostatic spray and are being used on a limited basis for topcoating automobiles, both foreign and domestic. The use of powder coatings is severely limited, however, because metallic finishes cannot be applied using powder. As with other high solids coatings, research is continuing in the use of powder coatings for the automotive industry.

Thermal incineration has been used to control VOC emissions from bake ovens in automobile and light-duty truck surface coating operations because of the fairly low volume and high VOC concentration in the exhaust stream. Incineration normally achieves a VOC emission reduction of over 90 percent. Thermal incinerators have not, however, been used for control of spray booth VOC emissions. Typically, the spray booth exhaust stream is a high volume stream (95,000 to 200,000 liters per second) which is very low in concentration of VOC (about 50 ppm). Thermal incineration of this exhaust stream would require a large amount of supplemental fuel, which is its main drawback for control of spray booth VOC emissions. There are no technical problems with the use of thermal incineration.

Catalytic incineration permits lower incinerator operating temperatures and, therefore, requires about 50 percent less energy than thermal incineration. Nevertheless, the energy consumption would still be high if catalytic incineration were used to control VOC emissions from a spray booth. In addition, catalytic incineration allows the owner or operator less choice in selecting a fuel; it requires the use of natural gas to preheat the exhaust gases, since oil firing tends to foul the catalyst. While catalytic incineration is not currently being employed in automobile and light-duty truck surface coating operations for control of VOC emissions, there are no technical problems which would preclude its use on either bake oven or spray booth exhaust gases. The primary limiting factor is the high energy consumption of natural gas, if catalytic incineration is used to control emissions from spray booths.

Carbon adsorption has been used successfully to control VOC emissions in a number of industrial applications. The ability of carbon adsorption to control VOC emissions from spray booths and bake ovens in automobile and light-duty truck surface coating operations, however, is uncertain. The presence of a high volume, low VOC exhaust stream from spray booths would require carbon adsorption units much larger than any that have ever been built. For bake ovens in automobile and light-duty truck surface coating operations, a major impediment to the use of carbon adsorption is heat. The high temperature of the bake oven exhaust stream would require the use of refrigeration to cool the gas stream before it passes through the carbon bed. Carbon adsorption, therefore, is not considered a demonstrated technology at this time for controlling VOC emissions from automobile and light-duty truck surface coating operations. Work is continuing within the automotive industry on efforts to apply carbon adsorption to the control of VOC emissions, however, and it may become a demonstrated technology in the near future.

Regulatory Options

Water-based coatings and incineration are two well-demonstrated and feasible techniques for controlling emissions of VOC from automobile and light-duty truck surface coating operations. Based upon the use of these two VOC emission control techniques, the following two regulatory options were evaluated.

Regulatory Option I includes two alternatives which achieve essentially equivalent control of VOC emissions. Alternative A is based on the use of water-based prime coats, guide coats, and topcoats. The prime coat would be applied by EDP. Since the guide coat is essentially a topcoat material, guide coat emission levels as low as those achieved by water-based topcoats should be possible through a transfer of technology from topcoat operations to guide coat operations. Alternative B is based on the use of a water-based prime coat applied by EDP and solvent-based guide coats and topcoats. Incineration of the exhaust gas stream from the topcoat spray booth and bake oven would be used to control VOC emissions under this alternative.

Regulatory Option II is based on the use of a water-based prime coat applied by EDP and solvent-based guide coats and topcoats. In this option, the exhaust gas streams from both the guide coat and topcoat spray booths and bake ovens would be incinerated to control VOC emissions.

Environmental, Energy, and Economic Impacts

Standards based on Regulatory Option I would lead to a reduction in VOC emissions of about 80 percent, and standards based on Regulatory Option II would lead to a reduction in emissions of about 90 percent, compared to VOC emissions from automobile and light-duty truck surface coating operations controlled to meet current SIP requirements. Growth projections indicate there will be four new automobile and light-duty truck

assembly lines constructed by 1983. Very few, if any, modifications or reconstructions are expected during this period. Based on these projections, national VOC emissions in 1983 would be reduced by about 4,800 metric tons with standards based on Regulatory Option I and about 5,400 metric tons with standards based on Regulatory Option II. Thus, both regulatory options would result in a significant reduction in VOC emissions from automobile and light-duty truck surface coating operations.

With regard to water pollution, standards based on Regulatory Option II would have essentially no impact. Similarly, standards based on Regulatory Option I(B) would have no water pollution impact. Standards based on Regulatory Option I(A), however, would result in a slight increase in the chemical oxygen demand (COD) of the wastewater discharged from automobile and light-duty truck surface coating operations within assembly plants. This increase is due to water-miscible solvents in the water-based guide coats and topcoats which become dissolved in the wastewater. The increase in COD of the wastewater, however, would be small relative to current COD levels at plants using solvent-based surface coatings and meeting existing SIP's. In addition, this increase would not require the installation of a larger wastewater treatment facility than would be built for an assembly plant which used solvent-based surface coatings.

The solid waste impact of the proposed standards would be negligible. The volume of sludge generated from water-based surface coating operations is approximately the same as that generated from solvent-based surface coating operations. The solid waste generated by water-based coatings, however, is very sticky, and equipment cleanup is more time consuming than for solvent-based coatings. Sludge from either type of system can be disposed of by conventional landfill procedures without leachate problems.

With regard to energy impact, standards based on Regulatory Option I(A) would increase the energy consumption of surface coating operations at a new automobile or light-duty truck assembly plant by about 25 percent. Regulatory Option I(B) would cause an increase of about 150 to 425 percent in energy consumption. Standards based on Regulatory Option II would result in an increase of 300 to 700 percent in the energy consumption of surface coating operations at a new automobile or light-duty truck assembly plant. The range in energy consumption for those options which are based on use of incineration reflects the difference between catalytic and thermal incineration.

The relatively high energy impact of standards based on Regulatory Option I(B) and Regulatory Option II is due to the large amount of incineration fuel needed. Standards based on Regulatory Option II would increase energy consumption at a new automobile and light-duty truck assembly plant by the equivalent of about 200,000 to 500,000 barrels of fuel oil per year, depending upon whether catalytic or thermal incineration was used. Standards based on Regulatory Option I(B) would increase energy consumption by the equivalent of about 100,000 to 300,000 barrels of fuel oil per year.

Standards based on Regulatory Option I(A) would increase the energy consumption of a typical new automobile and light-duty truck assembly plant by the equivalent of about 18,000 barrels of fuel oil per year. Approximately one-third of this increase in energy consumption is due to the use of air conditioning, which is necessary with the use of water-based coatings, and the remaining two-thirds are due to the increased fuel required in the bake ovens for curing water-based coatings.

Growth projections indicate that four new automobile and light-duty truck assembly lines (two automobile and two truck lines) will be built by 1983. Based on these projections, standards based on Regulatory Option I(A) would increase national energy consumption in 1983 by the equivalent of about 72,000 barrels of fuel oil. Standards based on Regulatory Option I(B) would increase national energy consumption in 1983 by the equivalent of 400,000 to 1,200,000 barrels of fuel oil, depending on whether catalytic or thermal incineration were used. Standards based on Regulatory Option II would increase national energy consumption in 1983 by the equivalent of 800,000 to 2,000,000 barrels of fuel oil, again depending on whether catalytic or thermal incineration were used.

The economic impacts of standards based on each regulatory option were estimated using the growth projection of four new assembly lines by 1983. Incremental control costs were determined by calculating the difference between the capital and annualized costs of new assembly plants controlled to meet Regulatory Options I(A), I(B), and II, respectively, with the corresponding costs for new plants designed to comply with existing SIP's. Of the four assembly plants projected by 1983, two were assumed to be lacquer lines and the other two enamel lines. There are basic design differences between these two types of surface coatings which have a substantial impact on the magnitude of the costs estimated to comply with standards of performance. Lacquer surface coating operations, for example, require much larger spray booths and bake ovens than enamel surface coating operations. Water-based systems also require large spray booths and bake ovens; thus, the incremental capital cost of installing a water-based system in a plant which would otherwise have used a lacquer system is relatively low. The incremental capital costs differential, however, would be much larger if the plant would have been designed for an enamel system.

Tables 1 and 2 summarize the economic impacts of the proposed standards on plants of typical sizes. Table 1 presents the incremental costs of the various control options for a plant which would have used solvent-based lacquers. Table 2 presents similar costs for plants which would have been designed to use solvent-based enamels. Though these tables present incremental costs for passenger car plants, light-duty truck plants would have similar cost differentials. In all cases, it is assumed the plants would install a water-based EDP prime system in the absence of standards of performance. Therefore, no incremental costs associated with EDP prime coat operations are included in the costs presented in Tables 1 and 2. A nominal production rate of 55 passenger cars per hour was assumed for both plants. Tables 1 and 2 show incremental capitalized and annualized costs per vehicle produced at each new facility. The manufacturers would probably distribute these incremental costs over their entire annual production to arrive at purchase prices for the automobiles and light-duty trucks.

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Table 1. INCREMENTAL CONTROL COSTS[a]

(Compared to the Costs of a Lacquer Plant)

	Regulatory Options				
	I(A)	I(B)		II	
	Water-Based Coatings	Thermal	Catalytic	Thermal	Catalytic
Capital Cost of Control Alternative	$ 720,000	$11,800,000	$15,000,000	$12,800,000	$16,200,000
Annualized Cost of Control Alternative	$1,550,000	$14,500,000	$10,700,000	$15,500,000	$11,500,000
Incremental Cost/Vehicle Produced at this Facility	$7.34	$68.66	$50.66	$73.39	$54.45

[a]Assumes a line speed of 55 vehicles per hour and an annual production of 211,200 vehicles.

Table 2. INCREMENTAL CONTROL COSTS[a]

(Compared to the Costs of an Enamel Plant)

	Regulatory Options				
	I(A)	I(B)		II	
	Water-Based Coatings	Thermal	Catalytic	Thermal	Catalytic
Capital Cost of Control Alternative	$10,300,000	$ 4,630,000	$ 5,850,000	$ 5,640,000	$ 7,000,000
Annualized Cost of Control Alternative	$ 3,640,000	$ 5,620,000	$ 4,150,000	$ 6,610,000	$ 4,890,000
Incremental Cost/Vehicle Produced at this Facility	$17.23	$26.61	$19.65	$31.30	$23.15

[a]Assumes a line speed of 55 vehicles per hour and an annual production of 211,200 vehicles.

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Incremental capital costs for suing incineration to reduce VOC emissions from solvent-based lacquer plants to levels comparable to water-based plants are much larger than they are for using incineration on a solvent-based enamel plant. This large difference in costs occurs because lacquer plants have larger spray booth and bake oven areas than enamel plants and, therefore, a larger volume of exhaust gases. Since larger incineration units are required, the incremental capital costs of using incineration to control VOC emissions from a solvent-based lacquer plant are about 15 to 25 times greater than they are for using water-based coatings. Similarly, energy consumption is much greater; hence, the annualized costs of using incineration are about 10 times greater than they are for using water-based coatings.

On the other hand, the incremental capital costs of controlling VOC emissions from new solvent-based enamel plants by the use of incineration are only about one-half the incremental capital costs between a new solvent-based enamel plant and a new water-based plant. Due to the energy consumption associated with incinerators, however, the incremental annualized costs of using incineration with solvent-based enamel coatings could vary from as little as 15 percent more to as much as 90 percent more than the annualized costs of using water-based coatings.

While the incremental capital costs of building a plant to use water-based coatings can be larger or smaller than the costs of using incineration, depending upon whether a solvent-based lacquer plant or a solvent-based enamel plant is used as the starting point, the annualized costs of using water-based coatings are always less than they are for using incineration. This is due to the large energy consumption of incineration units compared to the energy consumption of water-based coatings.

Since the incremental annualized costs are less with Regulatory Option I(A) than with Regulatory Option I(B), it is assumed in this analysis that Regulatory Option I(A) would be incorporated at any new, modified, or reconstructed facility to comply with standards based on Regulatory Option I. As noted, four new assembly plants are expected to be built by 1983. The incremental capital cost to the industry for these plants to comply with standards based on Regulatory Option I would be approximately $19 million. The corresponding incremental annualized costs would be about $9 million in 1983. If standards are based on Regulatory Option II, it is expected that the industry would choose catalytic incineration because its annualized costs are lower than those for thermal incineration. Based this assumption, the incremental capital costs for the industry under Regulatory Option II would be approximately $42 million, and the incremental annualized costs by 1983 would be about $30 million. For standards based on either Regulatory Option I or Regulatory Option II, the increase in the price of an automobile or light-duty truck that is manufactured at one of the new plants would be less than 1 percent of the base price of the vehicle.

Best System of Emission Reduction

Both Regulatory Options I and II achieve a significant reduction in VOC emissions compared to automobile and light-duty truck assembly plants controlled to comply with existing SIP's, and neither option creates a significant adverse impact on other environmental media. In terms of energy consumption, standards based on Regulatory Option II would have as much as 10 to 25 times the adverse impact on energy consumption as standards based on Regulatory Option I, while only achieving 10 to 15 percent more reductions in VOC emissions. The costs of standards based on Regulatory Option II range from two to three times the costs of standards based on Regulatory Option I. Thus, Regulatory Option I(A), water-based coatings, was selected as the best system of continuous emission reduction, considering costs and nonair quality health, and environmental and energy impacts.

Although water-based coatings are considered to be the best system of emission reduction at the present time, it is very likely that plants built in the future will use other systems to control VOC emissions, such as high solids coatings and powder coatings. High solids coatings applied at high transfer efficiencies are capable of achieving equivalent emission reductions and are expected to be less costly and require less total energy than water-based systems. These high solids coatings are expected to be available by 1982 and will probably be used by most new sources to comply with the VOC emission limitations. Powder coatings are also expected to be available in the future but are not demonstrated at this time.

Selection of Format for the Proposed Standards

A number of different formats could be selected to limit VOC emissions from automobile and light-duty truck surface coating operations. The format ultimately selected must be compatible with any of the three different control systems that could be used to comply with the proposed standards. One control system is the use of water-based coating materials in the prime coat, guide coat, and topcoat operations. Another control system is the use of solvent-based coating materials and add-on VOC emission control devices such as incineration. The third control system consists of the use of high solids coatings. Although the coatings to be used in this system are not demonstrated at this time, research is continuing toward their development; hence, they may be used in the future.

The formats considered were emission limits expressed in terms of (1) concentration of emissions in the exhaust gases discharged to the atmosphere; (2) mass emissions per unit of production; or (3) mass emissions per volume of coating solids applied.

The major advantage of the concentration format is its simplicity of enforcement. Direct emission measurements could be made using Reference Method 25. There are, however, two significant drawbacks to the use of this format. Regardless of the control approach chosen, emission testing would be required for each stack exhausting gases from the surface coating operations (unless the owner or operator could demonstrate to the Administrator's satisfaction that testing of representative stacks would give the same results as testing all the stacks). This testing would be time consuming and costly because of the large number of stacks associated with automobile and light-duty truck surface coating operations. Another potential problem with this format is the ease of circumventing the standards by the addition of dilution air. It would be extremely difficult to determine whether diluted air was being added intentionally to reduce the concentration of VOC emissions in the gases discharged to the atmosphere, or whether the air was being added to the application or drying operation to optimize performance and maintain a safe working space.

A format of mass VOC emissions per unit of production relates emissions to individual plant production on a direct basis. Where water-based coatings are used, the average VOC content of the coating materials could be determined

by using Reference Method 24 (Candidate 1 or Candidate 2). The volume of coating materials used and the percent solids could be determined from purchase records. VOC emissions could then be calculated by multiplying the VOC content of the coating materials by the volume of coating materials used in a given time period and by the percentage of solids, and dividing the result by the number of vehicles produced in that time period. This would provide a VOC emission rate per unit of production. Consequently, procedures to determine compliance would be direct and straightforward, although very time consuming. This procedure would also require data collection over an excessively long period of time.

Where solvent-based coatings were used with add-on emission control devices, stack emission tests could be performed to determine VOC emissions. Dividing VOC emissions by the number of vehicles produced would again yield VOC emissions per unit of production. This format, however, would not account for differences in surface coating requirements for different vehicles caused by size and configuration. In addition, manufactureres of larger vehicles would be required to reduce VOC emissions more than manufacturers of smaller vehicles.

A format of mass of VOC emissions per volume of coating solids applied also has the advantage of not requiring stack emission testing unless add-on emission control devices rather than water-based coatings are used to comply with the standards. The introduction of dilution air into the exhaust stream would not present a problem with this format. The problem of varying vehicle sizes and configurations would be eliminate since the format is in terms of volume of applied solids regardless of the surface area or number of vehicles coated. This format would also allow flexibility in selection of control systems, for it is usable with any of the control methods. Since this format overcomes the varying dilution air and vehicle size problems inherent with the other formats, it has been selected as the format for the proposed standards. In order to use a format which is in terms of applied solids, the transfer efficiency of the application devices must be considered. Transfer efficiency is defined as the fraction of the total sprayed solids which remain on the vehicle. Transfer efficiency is an important factor because as efficiency decreases, more coating material is used and VOC emissions increase. Equations have been developed to use this format with water-based coating materials as well as with solvent-based coating materials in combination with high transfer efficiences and/or add-on emission controls devices. These equations are included in the proposed standards.

Selection of Numerical Emission Limits

Numerical Emission Limits

The numerical emission limits selected for the proposed standard are:

- 0.10 kilogram of VOC per liter of applied coating solids from prime coat operations
- 0.84 kilogram of VOC per liter of applied coating solids from guide coat operations
- 0.84 kilogram of VOC per liter of applied coating solids from topcoat operations

In all three limits, the mass of VOC is measured as carbon in accordance with Reference Methods 24 (Candidate 1) and 25. These emission limits are based on the use of water-based coating materials in the prime coat, guide coat, and topcoat operations. Water-based coating data were obtained from plants which were using these materials as well as from the vendors who supply them. These data were used to calculate VOC emission limits using a procedure similar to proposed Method 24 (Candidate 1). A transfer efficiency of 40 percent was then applied to the values obtained for guide coat and top-coat emissions. This efficiency was determined to be representative of a well-operated air-atomized spray system. The CTG-recommended limits are based on the use of the same coating materials as the proposed standards. The limits in the CTG are expressed in pounds of VOC per gallon of coating (minus water) used in the EDP system or the spray device. The limits in these proposed standards, however, are referenced to the amount of coating solids which adhere to the vehicle body. Therefore, to compare the limits in the CTG to those proposed here, it is necessary to account for the solids content of the coating and the efficiency of applying the guide coat and topcoat to the vehicle body. Consideration of transfer efficiency is significant because the proposed standards can be met by using high solids content coating materials if the amount of overspray is kept to a minimum. Since this format provides equivalency determinations for systems using solvent-based coating materials in combination with high transfer efficiencies and/or add-on control devices, it allows flexibility in selection of control systems.

As discussed in previous sections, there are two types of EDP systems. Anodic EDP was the first type developed for use in automobile surface coating operations. Cathodic EDP is the second type and is a recent technology improvement which results in greater corrosion resistance. Consequently, nearly 50 percent of the existing EDP operations use cathodic systems, and continued changeovers from anodic to cathodic EDP are expected. Since cathodic EDP produces a coating with better corrosion resistance, the proposed standards are based on the best available cathodic EDP systems.

The coating material on which the EDP emission limit is based is presently in production use. Although this low solvent content material is currently available only in limited quantities, it is expected to be available in sufficient quantities for use in all new or modified sources before promulgation of the standard. The final promulgated standards will be based on this low solvent content material, rather than the EDP material commonly used now, if it is determined to be widely available at that time.

The emission limit for guide coat operations is based on a transfer of technology from topcoat operations. The guide coat is essentially a topcoat material, without pigmentation, and water-based topcoats are available which can comply with the proposed limits. Hence, the same emission limit is proposed for the guide coat operation as for the topcoat operation.

Because of the elevated temperatures present in the prime coat, guide coat, and topcoat bake ovens, additional amounts of "cure volatile" VOC may be emitted. These "cure volatile" emissions are present only at high temperatures and are not measured in the analysis which is used to determine the VOC content of coating materials. Cure volatile emissions, however, are believed to constitute only a small percentage of total VOC emissions. Consequently, because of the complexity of measuring and controlling cure volatile emissions, they will not be considered in determining compliance with the proposed standards.

A large number of coating materials are used in topcoat operations, and each may have a different VOC content. Hence, an average VOC content of all the coatings used in this operation would be computed to determine compliance with the proposed standards. Either of two averaging techniques could be used for computing this average. Weighted averages provide very accurate results but would require keeping records of the total volume and

percent solids of each different coating used. Arithmetic averages are not always as accurate; however, they are much simpler to calculate. In the case of topcoat operations, normally 15 to 20 different coatings are used, and the VOC content for most of these coatings is in the same general range. Therefore, an arithmetic average would closely approximate the values obtained from a weighted average. An arithmetic average would be calculated by summing the VOC content of each surface coating material used in a surface coating operation (i.e., guide coat or topcoat), and dividing the sum by the number of different coating materials used. Arithmetic averages are also consistent with the approach being incorporated into some revised SIP's.

For the EDP process, however, an arithmetic average VOC content is not appropriate to determine compliance with the proposed standards. In an EDP system, the coating material applied to an automobile or light-duty truck body is replaced by adding fresh coating materials to maintain a relatively constant concentration of solids, solvent, and fluid level in the EDP coating tank. Three different types of materials are usually added in separate streams—clear resin, pigment paste, and solvent.

The clear resin and pigment paste are very low in VOC content (i.e., 10 percent or less), while the solvent is very high in VOC content (i.e., 90 percent or more). The solvent additive stream is only about 2 percent of the total volume added. Consequently, an arithmetic average of the three streams seriously misrepresents the actual amount of VOC added to the EDP coating tank. Weighted averages, therefore, were selected for determining the average VOC content of coating materials applied by EDP.

If an automobile or light-duty truck manufacturer chooses to use a control technique other than water-based coatings, the transfer efficiency of the application devices used becomes very important. As transfer efficiency decreases, more coating material is used and VOC emissions increase. Therefore transfer efficiency must be taken into account to determine equivalency to water-based coatings.

Electrostatic spraying, which applies surface coatings at high transfer efficiences, can in many industries be used with water-based coatings if the entire paint handling system feeding the atomizers is insulated electically from ground. Otherwise, the high conductivity of the water involved would ground out and make ineffective the electrostatic effect. In the case of the coating of automobiles, however, because of the larger number of colors involved, the high frequency and speed of color changes required, the large volume of coatings consumed per shift, and the large number of both automatic and manual atomizers involved, it is not technically feasible to combine water-based coatings and electrostatic methods for reasons of complexity, cost, and personnel comfort. Consequently, water-based surface coatings are applied by air-atomized spray systems at a transfer efficiency of about 40 percent. The numerical emission limits included in the proposed standards were developed based on the use of water-based surface coatings applied at a 40 percent transfer efficiency. Therefore, if surface coatings are applied to a greater than 40 percent transfer efficiency, surface coatings with higher VOC contents may be used with no increase in VOC emissions to the atmosphere. Transfer efficiencies for various means of applying surface coatings have been estimated, based on information obtained from industries and vendors, as follows:

Application method:	Transfer efficiency (percent)
Air Atomized Spray	40
Manual Electrostatic Spray	75
Automatic Electrostatic Spray	95
Electrodeposition (EDP)	100

These values are estimates which reflect the high side of expected transfer efficiency ranges, and therefore, are intended to be used only for the purpose of determining compliance with the proposed standards.

Frequently, more than one application method is used within a single surface coating operation. In these cases, a weighted average transfer efficiency, based on the relative volume of coating sprayed by each method, will be estimated. These situations are likely to vary among the different manufacturers and the estimates, therefore, will be subject to approval by the Administrator on a case-by-case basis.

Method of Determining Compliance

The procedure for determining compliance with the proposed standards is complicated due to the number of different control systems which may be used. The following multistep procedure would be used.

1. Determine the average VOC content per liter of coating solids of the prime coat, guide coat, and topcoat materials being used. This would require analyzing all coating materials used in each coating operation using the proposed Reference Method 24 (Candidate 1 or Candidate 2) and calculating an average VOC content for each coating operation.

2. Select the appropriate transfer efficiency for each surface coating operation from the table included in the proposed standards.

3. Calculate the mass of VOC emissions per volume of applied solids for each surface coating operation by dividing the appropriate average VOC content of the coatings (Step 1) by the transfer efficiency of the surface coating operation (Step 2). If the value obtained is lower than the emission limit included in the proposed standards, the surface coating operation would be in compliance. If the value obtained is higher than the emission limit, add-on VOC emission control would be required to comply with the proposed standards.

4. If add-on emission control is required, calculate the emission reduction efficiency in VOC emissions which is required using the equations included in the proposed standards.

5. In cases where all exhaust gases are not vented to an emission control device, determine the percentage of total VOC emissions which enter the add-on emission control device by sampling all the stacks and using the equations included in the proposed standards. Representative sampling, however, could be approved by the Administrator, on a case-by-case basis, rather than requiring sampling of all stacks for this determination.

6. Calculate the actual efficiency of the control device by determining VOC emissions before and after the device using the proposed Reference Method 25.

7. Calculate the VOC emission reduction efficiency achieved by multiplying the percentage of VOC emissions which enter the add-on VOC emission control device (Step 5) by the add-on control device efficiency (Step 6). If the resulting value of the emission reduction efficiency achieved were greater than that required (Step 4), then the surface coating operation would be in compliance.

Detailed instructions, as well as the equations to be used for these calculations, are contained in the proposed standards.

Selection of Monitoring Requirements

Monitoring requirements are generally included in standards of performance to provide a means for enforcement personnel to ensure that emission control measures adopted by a facility to comply with standards of performance are properly operated and maintained. Surface coating operations which have achieved compliance with

the proposed standards without the use of add-on VOC emission control devices would be required to monitor the average VOC content (weighted averages for EDP and arithmetic averages for guide coat and topcoat) of the coating materials used in each surface coating operation. Generally, increases in the VOC content of the coating materials would cause VOC emissions to increase. These increases could be caused by the use of new coatings or by changes in the composition of existing coatings. Therefore, following the initial performance test, increases in the average VOC content of the coating materials used in each surface coating operation would have to be reported on a quarterly basis.

Where add-on control devices, such as incinerators, were used to comply with the proposed standards, combustion temperatures would be monitored. Following the initial performance test, decreases in the incinerator combustion temperature would be reported on a quarterly basis.

Performance Test Methods

Reference Method 24, "Determination of Volatile Organic Compound Content of Paint, Varnish, Lacquer, or Related Products," is proposed in two forms—Candidate 1 and Candidate 2. Candidate 1 leads to a determination of VOC content expressed as the mass of carbon. Candidate 2 yields a determination of VOC content measured as mass of volatile organics. The decision as to which Candidate will be used depends on the final format selected for the proposed standards. Reference Method 25, "Determination of Total Gaseous Nonmethane Volatile Organic Compound Emissions," is proposed as the test method to determine the percentage reduction of VOC emissions achieved by add-on emission control devices.

Public Hearing

A public hearing will be held to discuss the proposed standards in accordance with Section 307(d)(5) of the Clean Air Act. Persons wishing to make oral presentations should contact EPA at the address given above (see Addresses Section). Oral presentations will be limited to 15 minutes each. Any member of the public may file a written statement before, during, or within 30 days after the hearing. Written statements should be addressed to "Docket" (see Addresses Section).

A verbatim transcript of the hearing and written statements will be available for public inspection and copying during normal working hours at EPA's Central Docket Section, Room 2903B, Waterside Mall, 401 M Street, S.W., Washington, D.C. 20460.

Docket

The docket, containing all supporting information used by EPA to date, is available for public inspection and copying between 8:00 a.m. and 4:00 p.m., Monday through Friday, at EPA's Central Docket Section, Room 2903B, Waterside Mall, 401 M Street, S.W., Washington, D.C. 20460.

The docket is an organized and complete file of all the information submitted to or otherwise considered by EPA in the development of the rulemaking. The docket is a dynamic file, since material is added throughout the rulemaking development. The docketing system is intended to allow members of the public and industries involved to readily identify and locate documents so that they can intelligently and effectively participate in the rulemaking process. Along with the statement of basis and purpose of the promulgated rule and EPA responses to significant comments, the contents of the Docket will serve as the record in case of judicial review [Section 307(d)(a)].

Miscellaneous

As prescribed by Section 111, establishment of standards of performance for automobile and light-duty truck surface coating operations was preceded by the Administrator's determination (40 CFR 60.16, 44 FR 49222, dated August 21, 1979) that these sources contribute significantly to air pollution which may reasonably be anticipated to endanger public health or welfare. In accordance with Section 117 of the Act, publication of these standards was preceded by consultation with appropriate advisory committees, independent experts, and Federal departments and agencies. The Administrator welcomes comments on all aspects of the proposed regulations, including the technological issues, monitoring requirements, and the proposed test methods. Comments are requested specifically on Method 24 (Candidate 1 and Candidate 2) and the coating material used as the basis for the prime coat emission limit.

It should be noted that standards of performance for new sources established under Section 111 of the Clean Air Act reflect:

> . . . application of the best technological system of continuous emission reduction which (taking into consideration the cost of achieving such emission reduction, and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated [Section 111(a)(1)].

Although emission control technology may be available that can reduce emissions below those levels required to comply with standards of performance, this technology might not be selected as the basis of standards of performance because of costs associated with its use. Accordingly, standards of performance should not be viewed as the ultimate in achievable emission control. In fact, the Act may require the imposition of a more stringent emission standard in several situations.

For example, applicable costs do not necessarily play as prominent a role in determining the "lowest achievable emission rate" for new or modified sources locating in nonattainment areas (i.e., those areas where statutorily mandated health and welfare standards are being violated). In this respect, section 173 of the Act requires that new or modified sources constructed in an area which exceeds the NAAQS must reduce emissions to the level which reflects the LAER, as defined in section 171(3). The statute defines LAER as the rate of emissions based on the following, whichever is more stringent:

> (A) the most stringent emission limitation which is contained in the implementation plan of any State for such class or category of source, unless the owner or operator of the proposed source demonstrates that such limitations are not achievable, or
>
> (B) the most stringent emission limitation which is achieved in practice by such class or category of source.

In no event can the emission rate exceed any applicable new source performance standard.

A similar situation may arise under the prevention-of-significant-deterioration-of-air-quality provisions of the Act. These provisions require that certain sources employ BACT as defined in section 169(3) for all pollutants regulated under the Act. BACT must be determined on a case-by-case basis, taking energy, environmental and economic impacts, and other costs into account. In no event may the application of BACT result in emissions of any pollutants which will exceed the emissions allowed by any applicable standard established pursuant to section 111 (or 112) of the Act.

In all cases, SIP's approved or promulgated under section 110 of the Act must provide for the attainment and maintenance of NAAQS designed to protect public health and welfare. For this purpose, SIP's must, in some cases, require greater emission reduction than those required by standards of performance for new sources.

Finally, States are free under section 116 of the Act to establish even more stringent emission limits than those established under section 111 or those necessary to attain or maintain the NAAQS under section 110. Accordingly, new sources may in some cases be subject to limitations more stringent than standards of performance under section 111, and prospective owners and operators of new sources should be aware of this possibility in planning for such facilities.

Under EPA's sunset policy for reporting requirements in regulations, the reporting requirements in this regulation will automatically expire 5 years from the date of promulgation unless EPA takes affirmative action to extend them.

Section 317 of the Clean Air Act requires the Administrator to prepare an economic impact assessment for any new source standard of performance under section 111(b) of the Act. An economic impact assessment was prepared for the proposed regulations and for other regulatory alternatives. All aspects of the assessment were considered in the formulation of the proposed standards to ensure that the proposed standards would represent the best system of emission reduction considering costs. The economic impact assessment is included in the Background Information Document.

Dated: September 27, 1979.

Douglas M. Costle,

Administrator.

This proposed amendment to Part 60 of Chapter I, Title 40 of the Code of Federal Regulations would—

1. Add a definition of the term "volatile organic compound" to § 60.2 of Subpart A—General Provisions as follows:

§ 60.2 Definitions.

* * * * *

(dd) "Volatile Organic Compound" means any organic compound which participates in atmospheric photochemical reaction or is measured by the applicable reference methods specified under any subpart.

2. Add Subpart MM as follows:

Subpart MM—Standards of Performance for Automobile and Light-Duty Truck Surface Coating Operations

Sec.

60.390 Applicability and designation of affected facility.
60.391 Definitions.
60.392 Standards for volatile organic compounds.
60.393 Monitoring of operations.
60.394 Test methods and procedures.
60.395 Modifications.

Authority: Secs. 111 and 301(a) of the Clean Air Act, as amended, [42 U.S.C. 7411, 7601(a)], and additional authority as noted below.

Subpart MM—Standards of Performance for Automobile and Light-Duty Truck Surface Coating Operations

§ 60.390 Applicability and designation of affected facility.

(a) The provisions of this subpart apply to the following affected facilities in an automobile or light-duty truck surface coating line: each prime coat operation, each guide coat operation, and each topcoat operation.

(b) The provisions of this subpart apply to any affected facility identified in paragraph (a) of this section that begins construction or modification after ———— (date of publication in the Federal Register).

§ 60.391 Definitions.

All terms used in this subpart that are not defined below have the meaning given to them in the Act and in Subpart A of this part.

(a) "Automobile" means a motor vehicle capable of carrying no more than 12 passengers.

(b) "Automobile and light-duty truck body" means the body section rearward of the windshield and the front-end sheet metal or plastic exterior panel material forward of the windshield of an automobile or light-duty truck.

(c) "Bake oven" means a device which uses heat to dry or cure coatings.

(d) "Electrodeposition (EDP)" means a method of applying prime coat. The automobile or light-duty truck body is submerged in a tank filled with coating material, and an electrical field is used to deposit the material on the body.

(e) "Electrostatic spray application" means a spray application method that uses an electrical potential to increase the transfer efficiency of the coating solids. Electrostatic spray application can be used for prime coat, guide coat, or topcoat operations.

(f) "Flash-off area" means the structure on automobile and light-duty truck assembly lines between the coating application system (EDP tank or spray booth) and the bake oven.

(g) "Guide coat operation" means the guide coat spray booth, flash-off area and bake oven(s) which are used to apply and dry or cure a surface coating on automobile and light-duty truck bodies between the prime coat and topcoat operation.

(h) "Light-duty truck" means any motor vehicle rated at 3,850 kilograms (ca. 8,500 pounds) gross vehicle weight or less designed mainly to transport property.

(i) "Prime coat operation" means the prime coat application system (spray booth or dip tank), flash-off area, and bake oven(s) which are used to apply and dry or cure the initial coat on the surface of automobile or light-duty truck bodies.

(j) "Spray application" means a method of applying coatings by atomizing the coating material and directing this atomized spray toward the part to be coated. Spray applications can be used for prime coat, guide coat, and topcoat operations.

(k) "Spray booth" means a structure housing or manual spray application equipment where prime coat, guide coat, or topcoat is applied to automobile or light-duty truck bodies.

(l) "Surface coating operation" means any prime coat, guide coat, or topcoat operation on an automobile or light-duty truck surface coating line.

(m) "Topcoat operation" means the topcoat spray booth(s), flash-off area(s), and bake oven(s) which are used to apply and dry or cure the final coating(s) on automobile and light-duty truck bodies (i.e., those which give an automobile or light-duty truck body its color and surface appearance).

(n) "Transfer efficiency" means the fraction of the total applied coating solids which remains on the part.

(o) "Volatile organic compound" (VOC) means any organic compound which is measured by Method 24 (Candidate 1 or Candidate 2) and Method 25.

(p) "VOC emissions" means the mass of volatile organic compounds, expressed as kilograms of carbon per liter of applied coating solids, emitted from a surface coating operation.

(q) "VOC content" means the volatile organic compound content, in kilograms of carbon per liter of coating solids, of a coating material used in spray applications or coating make-up stream to an EDP tank.

§ 60.392 Standards for volatile organic compounds.

After the performance test required by § 60.8 has been completed, no owner or operator subject to the provisions of this subpart shall discharge or cause of the discharge into the atmosphere of VOC emissions which exceed the following limits:

(a) 0.10 kilogram of VOC (measured as mass of carbon) per liter of applied coating solids from each prime coat operation.

(b) 0.84 kilogram of VOC (measured as mass of carbon) per liter of applied coating solids from each guide coat operation.

(c) 0.84 kilogram of VOC (measured as mass of carbon) per liter of applied coating solids from each topcoat operation.

§ 60.393 Monitoring of operations.

(a) Any owner or operator subject to the provisions of this subpart shall—(1) Install, calibrate, operate, and maintain a monitoring device which records the combustion temperature of any effluent gases which are emitted from any surface coating operation and which are incinerated to comply with § 60.392. The manufacturer must certify that the monitoring device is accurate to within ±2°C (±3.6°F).

(2) Determine the weighted average VOC content of the coating materials used in any EDP prime coat operation whenever a change occurs in the composition of any of these coating materials. The owner or operator shall compute the weighted average by the following equation:

$$C = \frac{\sum_{i=1}^{n} CS_i \times VOLS_i \times SC_i}{\sum_{i=1}^{n} VOLS_i \times SC_i}$$

where:

C = the weighted averaged VOC content of all the coating materials used in an EDP system.

CS_i = the VOC content of the material in each coating makeup stream.

$VOLS_i$ = the volume (cubic meters) of each makeup stream added to the EDP tank during the previous month.

SC_i = the solid content of the material in each coating makeup stream expressed as a volume fraction.

n = the number of makeup streams.

(3) Determine the average VOC content of the coating materials in any surface coating operation which uses spray application whenever a change occurs in the composition of any of these coating materials. The owner or operator shall determine and record the arithmetic average of the VOC content of all coating materials in a coating operation which uses more than one coating material.

(b) Any owner or operator subject to the provisions of this subpart shall report for each calendar quarter all measurement results as follows:

(1) Where compliance with § 60.392 is achieved without the use of add-on control devices, any month during which—

(i) The weighted average VOC content of the makeup materials used in any prime coat operation employing EDP exceeds the most recent value which demonstrated compliance with § 60.392(a) by the performance test required in § 60.8.

(ii) The arithmetic average VOC content of the coating materials used in any surface coating operation employing spray application exceeds the most recent value which demonstrated compliance with § 60.392 by the performance test required in § 60.8.

(2) Where compliance with § 60.392 is achieved by the use of incineration, all periods in excess of 5 minutes during which the temperature in any incinerator used to control the emission from a surface coating operation remains below the most recent level which demonstrated compliance with § 60.392 by the performance tests required in § 60.8. The report required under § 60.7(c) shall identify each such occurrence and its duration.

(3) The reporting requirements in this regulation will automatically expire five years from the date of promulgation unless EPA takes affirmative action to extend them.

§ 60.394 Test methods and procedures.

(a) The reference methods in Appendix A to this part, except as provided for in § 60.8(b), shall be used to determine compliance with § 60.392 as follows:

(1) The owner or operator shall use Reference Method 24 (Candidate 1 or Candidate 2) to measure the VOC content of every coating or makeup material used in each surface coating operation of an automobile or light-duty truck surface coating line. The coating sample shall be a 1 liter sample taken at a point where the sample will be representative of the coating material as applied to the vehicle surface. The 1 liter sample shall be divided into three aliquots for triplicate determinations by Method 24 (Candidate 1 or Candidate 2).

(2) The owner or operator shall compute the arithmetic average VOC content of all coating materials used in each surface coating operation that uses spray application.

(3) The owner or operator shall use the calculation procedures given in § 60.393(a)(2) to compute the weighted average VOC content of all makeup materials added to an EDP tank during a selected one month period for each prime coat operation that uses EDP.

(4) The owner or operator shall determine the VOC emissions by the equation:

$$E = \frac{C}{TE}$$

where:

E = the VOC emissions.

C = the average VOC content of all the coating or makeup materials used in that operation. The owner or operator shall use an arithmetic average for systems using spray application and a weighted average for systems using EDP.

TE = the appropriate transfer efficiency as determined in paragraph (a)(5) of this section.

(5) The owner or operator shall select the appropriate transfer efficiency from the following table for each surface coating operation.

Application method	Transfer efficiency (TE)
Air Atomized Spray	0.40
Manual Electrostatic Spray	0.75
Automatic Electrostatic Spray	0.95
Electrodeposition	1.00

If the owner or operator can justify to the Administrator's satisfaction that other values for transfer efficiencies are appropriate, the Administrator will approve their use on a case-by-case basis. Where more than one application method is used on an individual surface coating operation, the owner or operator shall perform an analysis to determine the relative volume of solids coating materials applied by each method. The owner or operator shall use these relative volumes of solids to compute a weighted average transfer efficiency for the operation. The Administrator will review and approve this analysis on a case-by-case basis.

(b) For each surface coating operation which cannot achieve compliance with § 60.392 without the use of add-on control devices, the owner or operator shall use the following procedures to determine that the emission reduction efficiency of the control device(s) is sufficient to achieve compliance with § 60.392:

(1) The owner or operator shall compute the emission reduction efficiency required for each surface coating operation by the following equation:

$$ER = \frac{E - EL}{E} \times 100$$

where:

ER = the required emission reduction efficiency (in percent) for the applicable surface coating operation to achieve compliance with § 60.392.

E = the VOC emissions from the applicable surface coating operation.

EL = the numerical VOC emission limit in § 60.392 for the applicable surface coating operation.

(2) The owner or operator shall determine the emission reduction efficiency achieved by the control device(s) on each applicable surface coating operation as follows:

(i) The owner or operator shall use Reference Method 25 to determine the

VOC concentration in the effluent gas before and after the emission control device for each stack that is equipped with an emission control device. The owner or operator shall use Reference Method 2 to determine the volumetric flowrate of the effluent gas before and after the emission control device on each stack. The Administrator will approve testing of representative stacks, on a case-by-case basis, if the owner or operator can show to the Administrator's satisfaction that testing of representative stacks yields results comparable to those that would be obtained by testing all stacks.

(ii) For Method 25, the sampling time for each run shall be at least 60 minutes and the minimum sample volume shall be at least 0.003 dscm (0.106 dscf) except that shorter sampling times or smaller volumes, when necessitated by process variables or other factors, may be approved by the Administrator.

(iii) The owner or operator shall determine the efficiency of each emission control device by the following equation:

$$EFF = \frac{(CB \times VOLB) - (CA \times VOLA)}{(CB \times VOLB)} \times 100$$

where:

EFF = the emission control device efficiency, in percent.

CB = the concentration of VOC in the effluent gas before the emission control device, in parts per million by volume.

CA = the concentration of VOC in the effluent gas after the emission control device, in parts per million by volume.

VOLA = the volumetric flow rate of the effluent gas after the emission control device, in dry standard cubic meters per second.

VOLB = the volumetric flow rate of the effluent gas before the emission control device, in dry standard cubic meters per second.

If an emission control device controls the emissions from more than one stack, the owner or operator shall measure CB and VOLB at a location between the manifold that receives all the exhausts from the applicable surface coating operation and the control device. If a manifold is not used, the product CB × VOLB shall be replaced by the sum of the individual products for each stack on the applicable surface coating operation controlled by this device.

(iv) The owner or operator shall determine the fraction of the total VOC discharged from an applicable surface coating operation which enters each emission control device on that operation by the following equation:

$$F_i = \frac{CB_i \times VOLB_i}{\sum_{k=1}^{n} (CB_k \times VOLB_k)}$$

where:

F_i = the fraction of the total VOC discharged from the applicable surface coating operation which enters the emission control device.

CB_i = the value of CB for stack (k) on the applicable surface coating operation.

CB_k = the value of CB for each stack (k) on the applicable surface coating operation.

$VOLB_i$ = the value of VOLB for each emission control device (i).

$VOLB_k$ = the value of VOLB for each stack (k) on the applicable surface coating operation.

n = the number of stacks on the applicable surface coating operation.

The owner or operator shall use the procedures contained in clause (ii) of this subparagraph for any emission control device (i) that controls the emissions from more than one stack.

(v) The owner or operator shall determine the emission reduction efficiency achieved by the control device(s) on the applicable surface coating operation using the equation:

$$EA = \sum_{i=1}^{m} (F_i \times EFF_i)$$

where:

EA = the emission reduction efficiency achieved, in percent.

EFF_i = the emission reduction efficiency (in percent) of each control device on the applicable surface coating operation.

m = the number of control devices on the applicable surface coating operation.

(3) If EA is greater than or equal to ER, the applicable surface coating operation will be in compliance with § 60.392.

§ 60.395 Modifications.

(a) The following physical or operational changes are not, by themselves, considered modifications of existing facilities:

(1) Changes as a result of model year changeovers or switches to larger cars.

(2) Changes in the application of the coatings to increase paint film thickness.

Appendix A—Reference Methods

3. Method 24 (Candidate 1), Method 24 (Candidate 2), and Method 25 are added to Appendix A as follows:

* * * * *

Method 24 (Candidate 1)—Determination of Volatile Content (as Carbon) of Paint, Varnish, Lacquer, or Related Products

1. Applicability and Principle

1.1 Applicability. This method is applicable for the determination of volatile content (as carbon) of paint, varnish, lacquer, and related products listed in Section 2.

1.2 Principle. The weight of volatile carbon per unit volume of solids is calculated for paint, varnish, lacquer, or related surface coating after using standard methods to determine the volatile matter content, density of the coating, density of the solvent, and using the oxidation-nondispersive infrared (NDIR) analysis for the carbon content.

2. Classification of Surface Coating

For the purpose of this method, the applicable surface coatings are divided into two classes. They are:

2.1 Class I: General Solvent-Type Paints and Water Thinned Paints. This class includes white linseed oil outside paint, white soya and phthalic alkyd enamel, white linseed o-phthalic alkyd enamel, red lead primer, zinc chromate primer, flat white inside enamel, white epoxy enamel, white vinyl toluene, modified alkyd, white amino modified baking enamel, and other solvent-type paints not included in class II. It also includes emulsion or latex paints and colored enamels.

2.2 Class II: Varnishes and Lacquers. This class includes clear and pigmented lacquers and varnishes.

3. Applicable Standard Methods

Use the apparatus, reagents, and procedures specified in the standard methods below:

3.1 ASTM D 1644–59 Method A: Standard Methods of test for Non-volatile Contents of Varnishes. Do not use Method B.

3.2 ASTM D 1475–60. Standard Method of Test for Density of Paint, Lacquer, and Related Products.

3.3 ASTM D 2369–73: Standard Method of Test for Volatile Content of Paints.

3.4 ASTM D 3272–76: Standard Recommended Practice for Vacuum Distillation of Solvents from Solvent-Base Paints for Analysis.

4. Apparatus (Oxidation/NDIR Procedure)

4.1 Electric Furnace. Capable of maintaining a temperature of 800 ± 50° C.

4.2 Combustion Chamber. Stainless steel tubing, 13 mm (½ in.) internal diameter and 46 cm (18 in.) in length. Pack the tube loosely with 3 mm (⅛ in.) alumina pellets coated with 5 percent palladium. Place plugs of stainless steel wool at either end. Other catalytic systems which can demonstrate 95 percent efficiency as described in Section 6.5.4 are considered equivalent.

4.3 Septum. Teflon [1]-coated rubber septum.

4.4 Condenser. Ice bath condenser.

4.5 Analyzer. Nondispersive infrared analyzer (NDIR) to measure CO_2 **TO WITHIN ◇5 PERCENT OF THE CALIBRATION GAS CONCENTRATION.**

4.6 Recorder. Capable of matching the output of the NDIR.

4.7 Collection Tank. A collection tank of at least 6 liters in volume. See procedure in Section 6.5.1 for calibrating the volume of the tank. The tank should be capable of

[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

withstanding a pressure of 2000 mm (80 in.) Hg (gauge).

4.8 Pressure Gauge for Collection Tank. Capable of measuring positive pressure to 1100 mm (42 in.) Hg and vacuum pressure to 700±5 mm (28±0.25 in.) Hg.

4.9 Vacuum Pump. Capable of evacuating the collection tank to an absolute pressure of 51 mm (2 in.) Hg.

4.10 Analytical Balance. To measure to within ±0.5 mg.

4.11 Syringes. 100±1.0 µl, 500±1.0 µl, and 1000±5 µl syringe, with needles long enough to inject sample directly into the carrier gas stream.

4.12 Mixer. Vortex-mixer to ensure homogeneous mixing of solvent.

4.13 Flow Regulators. Rotameters, or equivalent, to measure to 500 cc/min in flow-rate.

4.14 Temperature Gauge. A thermometer graduated in 0.1° C, with range from 0° C to 100° C.

4.15 Tank Calibration Equipment. A balance to weigh collection tank to ±30 g or a graduated glass cylinder to measure tank volume within ±30 ml.

5. Reagents (Oxidation/NDIR Procedure)

5.1 Calibration Gases.

5.1.1 Zero Gas. Nitrogen.

5.1.2 CO_2 Gas. A range of concentration to allow at least a 3-point calibration of each measuring range of the instrument.

5.1.3 Carrier Gas. Air containing less than 1 ppm hydrocarbon as carbon, as certified by the manufacturer.

5.2 Catalyst. Alumina (3 mm pellets) coated with 5 percent palladium, or equivalent (commercially available).

5.3 Acetone. Reagent grade.

5.4 Nitric Acid Solution. Dilute 70 percent nitric acid 1:1 by volume with distilled water.

5.5 1-Butanol. Ninety-nine molecular percent pure.

5.6 Methane Gas. 0.5 percent methane in air.

6. Procedure

6.1 Classification of Samples. Assign the coating to one of the two classes discussed in Section 2 above. Assign any coating not clearly belonging to Class II to Class I.

6.2 Volatile Content. Use one of the following methods to determine the volatile content according to the class of coating.

6.2.1 Class I. Use the Procedure in ASTM D 2369–73. Record the following information:
W_1 = Weight of dish and sample, g.
W_2 = Weight of dish and sample after heating, g.
S = Sample weight, g.
Repeat the procedure for a total of three determinations for each coating. Calculate the weight fraction of volatile matter W for each analysis as follows:

$$W = \frac{W_1 - W_2}{S}$$

Report the arithmetic average weight fraction $\bar{W}$ of the three determinations.

6.2.2 Class II. Use the procedure in ASTM D 1644–59 Method A; record the following information:
A = Weight of dish, g.
B = Weight of sample used, g.
C = Weight of dish and sample after heating, g.
Repeat the procedure for a total of three determinations for each coating. Calculate the weight fraction W of volatile content for each analysis as follows:

$$W = \frac{(A + B - C)}{B}$$

Report the arithmetic average weight fraction $\bar{W}$ of three determinations.

6.3 Coating Density. Determine the density D_m (in g/cm³) of the paint, varnish, lacquer, or related product of either class according to the procedure outlined in ASTM D 1475–60. Make a total of three determinations for each coating. Report the density $\bar{D}_m$ as the arithmetic average of the three determinations.

6.4 Solvent Density.

6.4.1 Perform the solvent extraction according to the procedure outlined in ASTM D 3272–76. For aqueous paint, use a collection-tube in an ice-bath prior to the collection-tube in the acetone and dry-ice mixture to prevent water from freezing in the collection-tube. Combine the contents of both tubes before analysis. If excessive foaming occurs during distillation, discard the sample, and repeat with a new sample treated with an anti-foam spray (e.g. Dow Corning's "Anti-foam A Spray) before distillation. Anti-foam spray must be nonorganic and nonflammable. Use spray sparingly.

6.4.2 Determine the density D_s (in g/cm³) of the solvent according to the procedure outlined in ASTM D 1475–60. Make a total of three determinations for the solvent, and report the average density $\bar{D}_s$ as the arithmetic average of the three determinations.

6.5 Carbon Content of the Solvent. Analyze the solvent within 24 hours after distillation; keep it under refrigeration when not in use. To determine the carbon content, follow the procedure below:

6.5.1 Clean and calibrate the collection tank as follows: Rinse the inside of the tank once with acetone, twice with tap water, thrice with the nitric acid solution, and twice with tap water. Weigh the tank when empty and when full of water. Measure the temperature of the water, and calculate the volume as follows:

$$V = \frac{W_f - W_e}{D_t}$$

Where:
t = Temperature of the water, °C (°F).
V = Volume of the tank, ml.
W_e = Weight of the empty tank, g.
W_f = Weight of the full tank, g.
D_t = Density of water at temperature t, g/ml.
Alternatively, measure the volume of water necessary to fill the tank. The volume of the tank connections and pressure gauge are negligible for a tank volume of at least 6 liters.

6.5.2 Calibrate the NDIR according to the manufacturer's instruction. Use at least a 3-point calibration. Introduce the CO_2 calibration gas through the analysis line.

6.5.3 Assemble the oxidation system as shown in Figure 1. Heat the catalyst until the temperature reaches equilibrium at 800 ±50° C. Add ice to the condenser and remove excess water to maintain the temperature at 0° C.

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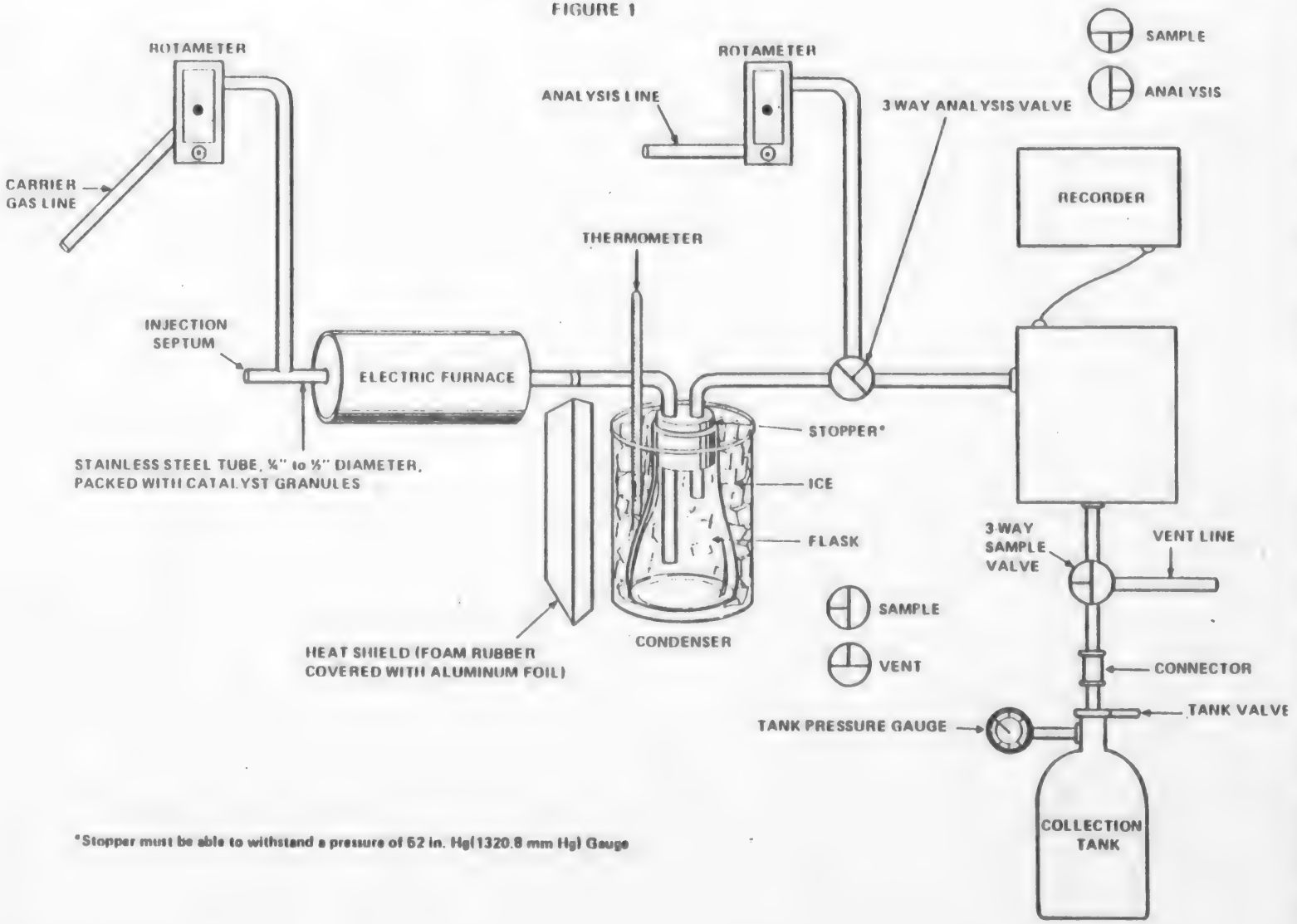
FIGURE 1



*Stopper must be able to withstand a pressure of 52 in. Hg(1320.8 mm Hg) Gauge

6.5.4 Determination of Conversion Efficiency. Pass 0.5 percent methane gas in air through carrier gas line; 0.5 percent CO_2 should be generated within ±5 percent error. Using a 100 μl sample of l-butanol, follow the procedure in 6.5.5 to 6.5.13. Calculate the theoretical CO_2 volume percent as in Section 7.3. This value should equal the value as measured by the NDIR, within ±5 percent error. If conversion efficiency is 100 ±5 percent, analyze the solvent extracted from the paint according to procedure in Sections 6.5.5 to 6.5.14.

6.5.5 Purge the collection tank twice with N_2, then evacuate the tank to at least 50.8 mm (2 in.) Hg absolute pressure. Connect the cylinder to the collection line.

6.5.6 Mix the solvent sample thoroughly on a vortex-mixer. Then, draw a sample (0.100 to 0.300 ml) into the syringe. Record the volume of sample used.

6.5.7 Turn analysis valve to "sample" position, and turn the sample valve to "vent" position. Then turn on the carrier gas at a rate of 500 cc/min to flush the system for 2 minutes.

6.5.8 With gas flowing at 500 cc/min (maintain this rate throughout the test procedure), turn sample valve to "sample" position. Open the tank valve and inject the sample into the gas stream through the injection septum. Continue to draw the sample into the tank until the NDIR reads zero. (Note.— On replicate samples, a decrease in peak value indicates that the catalyst or sample has deteriorated, assuming that other factors, such as leaks, cell contamination, mechanical defects of the instruments, etc., have not occurred.)

6.5.9 At completion of collection, close the tank valve, and turn sample valve to "vent" position. Let the carrier gas flush the system for 2 minutes, then turn off the carrier gas.

6.5.10 Disconnect the tank and pressurize it with N_2 to about 1016 mm (40 in.) Hg gauge pressure. Record the final tank pressure after pressurization, the atmospheric pressure, and the room temperature.

6.5.11 Connect the tank to the analysis line and turn the analysis valve to "analysis" position.

6.5.12 Pass the CO_2 sample gas at the same rate as the calibration gas. Keep the rate constant by adjusting the rotameter as tank pressure falls.

6.5.13 Record the CO_2 concentration when the peak value is reached. This peak value will remain constant as long as the sample gas continues to flow at a constant rate.

6.5.14 Repeat steps 6.5.5 through 6.5.13 until three consecutive results are obtained which differ from one another in value by no more than ±5 percent. At the end of the third test, check the catalyst function by passing the collected sample gas through the catalyst and into the NDIR. No increase in concentration value should occur. If the concentration is higher, invalidate the test series, replace the catalyst and repeat the test.

6.5.15 Report the results as an arithmetic average of the three determinations.

7. Calculations. Carry out the calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after decimal calculation.

7.1 Nomenclature.

C_c = Volatile matter content as carbon per unit volume of paint solids, g/l (lb/gal).

D_b = Density of l-Butanol, g/cm³.

D_m = Average coating density, g/cm³ (See Section 6.3).

D_s = Average solvent density, g/cm³ (See Section 6.4).

L_b = Volume of l-Butanol used in the test, cm³.

L_s = Volume of paint solvent used in the test, cm³.

74.12 = Molecular weight of l-Butanol.

M_c = Mass of carbon, g.

4 = Number of carbon atoms in l-Butanol.

P_{std} = Absolute standard pressure, 760 mm Hg (29.92 in. Hg).

P_f = Absolute final tank pressure after pressurization, mm Hg (in. Hg).

T_{std} = Absolute standard temperature, 293° K (528° R).

T_t = Absolute tank temperature, °K (°R).

%Solv. = Volume percent of solvent in paint coating.

V_{CO_2} = Volume of CO_2 in liters, at standard temperature and pressure.

V_{gs} = Total gas volume, corrected to standard conditions, in liters.

V_{pc} = Volume percent of CO_2.

V_t = Volume of tank, liters.

W = Weight fraction of volatile matter content.

7.2 Total Gas Volume, Corrected to Standard Conditions.

$$V_{gs} = \frac{T_{std}}{P_{std}} \frac{P_f}{T_t} V_t = K_1 \frac{P_f}{T_t} V_t \qquad \text{Equation 1}$$

Where:

K_1 = 17.65 for English units.

K_1 = 0.3855 for Metric units.

7.3 Volume Percent of CO_2 From l-Butanol:

$$V_{pc} = \frac{1.298\ L_b\ D_b}{V_{gs}} \qquad \text{Equation 2}$$

7.4 Mass of Carbon

$$M_c = V_{pc}\ V_{gs}\ \frac{12.0}{24.056}\ \frac{1}{100} \qquad \text{Equation 3}$$

7.5 Percent Volume Solvent in Paint.

$$\%Solv. = W\ \frac{D_m}{D_s}\ (100) \qquad \text{Equation 4}$$

7.6 Volatile Matter Content as Carbon.

$$C_c = K_2\ \frac{M_c}{L_s}\ \frac{\%Solv.}{100 - \%Solv.} \qquad \text{Equation 5}$$

Where:

K_2 = 8.3445 for English units.

K_2 = 1000 for Metric units.

8. Bibliography.

8.1 Standard Methods of Test for Nonvolatile Content of Varnishes. In: 1974 Book of ASTM Standards, Part 27. Philadelphia, Pennsylvania, ASTM Designation D 1644–59. 1974. p. 285–286.

8.2 Standard Method of Test for Volatile Content of Paints. In: 1978 Book of ASTM Standards, Part 27. Philadelphia, Pennsylvania, ASTM Designation D 2369–73. 1978. p. 431–432.

8.3 Standard Method of Test for Density of Paint, Varnish, Lacquer, and Related Products. In: 1974 Book of ASTM Standards, Part 25. Philadelphia, Pennsylvania, ASTM Designation D 1476–60. 1974. p. 231–233.

8.4 Standard Recommended Practice for Vacuum Distillation of Solvents from Solvent-Base Paints for Analysis. In: 1978 Annual Book of ASTM Standards, Part 27. Philadelphia, Pennsylvania, ASTM Designation D 3272076. 1978. p. 612–614.

8.5 Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Total Combustion Analysis. Air Pollution Control District-County of Los Angeles. August 1974.

Method 24 (Candidate 2)— Determination of Volatile Organic Compound Content (as Mass) of Paint, Varnish, Lacquer, or Related Products

1. *Applicability and Principle.*

1.1 Applicability. This method applies to the determination of volatile organic compound content (as mass) of paint, varnish, lacquer, and related products listed in Section 2.

1.2 Principle. Standard methods are used to determine the volatile matter content, density of the coating, volume of solid, and water content of the paint, varnish, lacquer, and related surface coating. From this information, the mass of volatile organic compounds per unit volume of solids is calculated.

2. *Classification of Surface Coating.* For the purpose of this method, the applicable surface coatings are divided into three classes. They are:

2.1 Class I: General Solvent Reducible Paints. This class includes white linseed oil outside paint, white soya and phthalic alkyd enamel, white linseed o-phthalic alkyd enamel, red lead primer, zinc chromate primer, flat white inside enamel, white epoxy enamel, white vinyl toluene, modified alkyd, white amino modified baking enamel, and other solvent-type paints not included in Class II.

2.2 Class II: Varnishes and Lacquers. This class includes clear and pigmented lacquers and varnishes.

2.3 Class III. This class includes all water reducible paints.

3. *Applicable Standard Methods.* Use the apparatus, reagents, and procedures specified in the standard method below:

3.1 ASTM D 1644–75 Method A: Standard Method of Test for Non-volatile Contents of Varnishes. Do not use Method B.

3.2 ASTM D 1475–60. Standard Method of Test for Density of Paint, Lacquer, and Related Products.

3.3 ASTM D 2369–73. Standard Method of Test for Volatile Content of Paints.

3.4 ASTM D 2697–73. Standard Method of Test for Volume Non-volatile Matter in Clear or Pigmented Coatings.

3.5 ASTM D 3792. Standard Method of Test for Water in Water Reducible Paint by Direct Injection into a Gas Chromatograph.

3.6 ASTM Draft Method of Test for Water in Paint or Related Coatings by the Karl Fischer Titration Method.

4. *Procedure.*

4.1 Classification of Samples. Assign the coating to one of the three classes discussed in Section 2 above. Assign any coating not clearly belonging to Class II or III to Class I.

4.2 Non-Aqueous Volatile Content. Use one of the following methods to determine the non-aqueous volatile content according to the class of coating.

4.2.1 Class I. Use the procedure in ASTM D 2369–73; record the following information:

W_1 = Weight of dish and sample, g.
W_2 = Weight of dish and sample after heating, g.
S = Sample of weight, g.

Repeat the procedure for a total of three determinations for each coating. Calculate the weight fraction of non-aqueous volatile matter W_v for each analysis as follows:

$$W_v = \frac{W_1 - W_2}{S}$$

Report the arithmetic average weight fraction W_v of the three determinations.

4.2.2 Class II. Use the procedure in ASTM D 1644–75 Method A; record the following information:

A = Weight of dish, g.
B = Weight of sample used, g.
C = Weight of dish and sample after heating, g.

Repeat the procedure for a total of three determinations for each coating. Calculate the weight fraction W_v of non-aqueous volatile content for each analysis as follows:

$$W_v = \frac{(A + B - C)}{B}$$

Report the arithmetic average weight fraction W_v of the three determinations.

4.2.3 Class III.

4.2.3.1 Water Content. Determine the water content (in % H_2O) of the coating according to either "Provisional Method of Test for Water in Water Reducible Paint by Direct Injection into a Gas Chromatograph" or "Provisional Method of Test for Water in Paint or Related coatings by the Karl Fischer Titration Method." Repeat the procedure for a total of three determinations for each coating. Report the arithmetic average weight percent % H_2O of the three determinations.

4.2.3.2 Volatile Content (Including Water). Use the procedure in ASTM D 2369–73; record the following information:

W_1 = Weight of dish and sample, g.
W_2 = Weight of dish and sample after heating, g.
S = Sample weight, g.

Repeat the procedure for a total of three determinations for each coating. Calculate the weight fraction of volatile matter as follows:

$$V = \frac{W_1 - W_2}{S}$$

Report the arithmetic average weight fraction V of the three determinations.

4.2.3.3 Non-Aqueous Volatile Matter. Calculate the average non-aqueous volatile matter W_v as follows:

$$\bar{W}_v = \bar{V} - \frac{\overline{\% H_2O}}{100}$$

4.3 Coating Density. Determine the density D_m (in g/cm³) of the paint, varnish, lacquer, or related product of any class according to the procedure outlined in ASTM D 1475–60. Make a total of three determinations for each coating. Report the density D_m as the arithmetic average of the three determinations.

4.4 Non-Volatile Content. Determine the volume fraction of the non-volatile matter of the coating of any class according to the procedure outlined in ASTM D 2697–73. Calculate the volume fraction P_n of non-volatile matter as follows:

$$P_n = \frac{\% \text{ Volume Nonvolatile Matter}}{100}$$

Make a total of three determinations for each coating. Report the arithmetic average volume fraction P_n of the three determinations.

5. *Volatile Organic Compounds Content.* Calculate the volatile organic compound content C_m in terms of mass per volume of solids (g/liter) as follows:

$$C_m = \frac{\bar{W}_v \bar{D}_m}{\bar{P}_n}$$

To convert g/liter to lb/gal, multiply C_m by 8.3455×10^{-3}.

6. *Bibliography.*

6.1 Standard Methods of Test of Nonvolatile Content of Varnishes. In: 1974 Book of ASTM Standards, Part 27. Philadelphia, Pennsylvania, ASTM Designation D 1644–75. 1978. p. 288–289.

6.2 Standard Method of Test for Volatile Content of Paints. In: 1978 Book of ASTM Standards, Part 27. Philadelphia, Pennsylvania, ASTM Designation D 2369–73. 1978. p. 431–432.

6.3 Standard Method of Test for Density of Paint, Varnish, Lacquer, and Related Products. In: 1974 Book of ASTM Standards, Part 25. Philadelphia, Pennsylvania, ASTM Designation D 1476–60. 1974. p. 231–233.

6.4 Standard Method of Test for Water in Water Reducible Paint by Direct Injection into a Gas Chromatograph. Available from: Chairman, Committee D–1 on Paint and Related Coatings and Materials, American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103. ASTM Designation D 3792.

6.5 Draft method of Test for Water in Paint or Related Coatings by the Karl Fischer Titration Method. Available from: Chairman, Committee D–1 on Paint and Related Coatings and Materials, American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

Method 25—Determination of Total Gaseous Nonmethane Organic Emissions as Carbon: Manual Sampling and Analysis Procedure

1. Principle and Applicability.

1.1 Principle. An emission sample is anisokinetically drawn from the stack through a chilled condensate trap by means of an evacuated gas collection tank. Total gaseous nonmethane organics (TGNMO) are determined by combining the analytical results obtained from independent analyses of the condensate trap and evacuated tank fractions. After sampling is completed, the organic contents of the condensate trap are oxidized to carbon dioxide which is quantitatively collected in an evacuated vessel; a portion of the carbon dioxide is reduced to methane and measured by a flame ionization detector (FID). A portion of the sample collected in the gas sampling tank is injected into a gas chromatographic (GC) column to achieve separation of the nonmethane organics from carbon monoxide, carbon dioxide and methane; the nonmethane organics are oxidized to carbon dioxide, reduced to methane, and measured by a FID.

1.2 Applicability. This method is applicable to the measurement of total gaseous nonmethane organics in source emissions.

2. Apparatus.

2.1 General. TGNMO sampling equipment can be constructed by a laboratory from commercially available components and components fabricated in a machine shop. The primary components of the sampling system are a condensate trap, flow control system, and gas sampling tank (Figure 1). The analytical system consists of two major subsystems; an oxidation system for recovery of the sample from the condensate trap and a TGNMO analyzer. The TGNMO analyzer is a FID preceded by a reduction catalyst, oxidation catalyst, and GC column with backflush capability (Figures 2 and 3). The system for the removal and conditioning of the organics captured in the condensate trap consists of a heat source, oxidation catalyst, nondispersive infrared (NDIR) analyzer and an intermediate gas collection tank (Figure 4).

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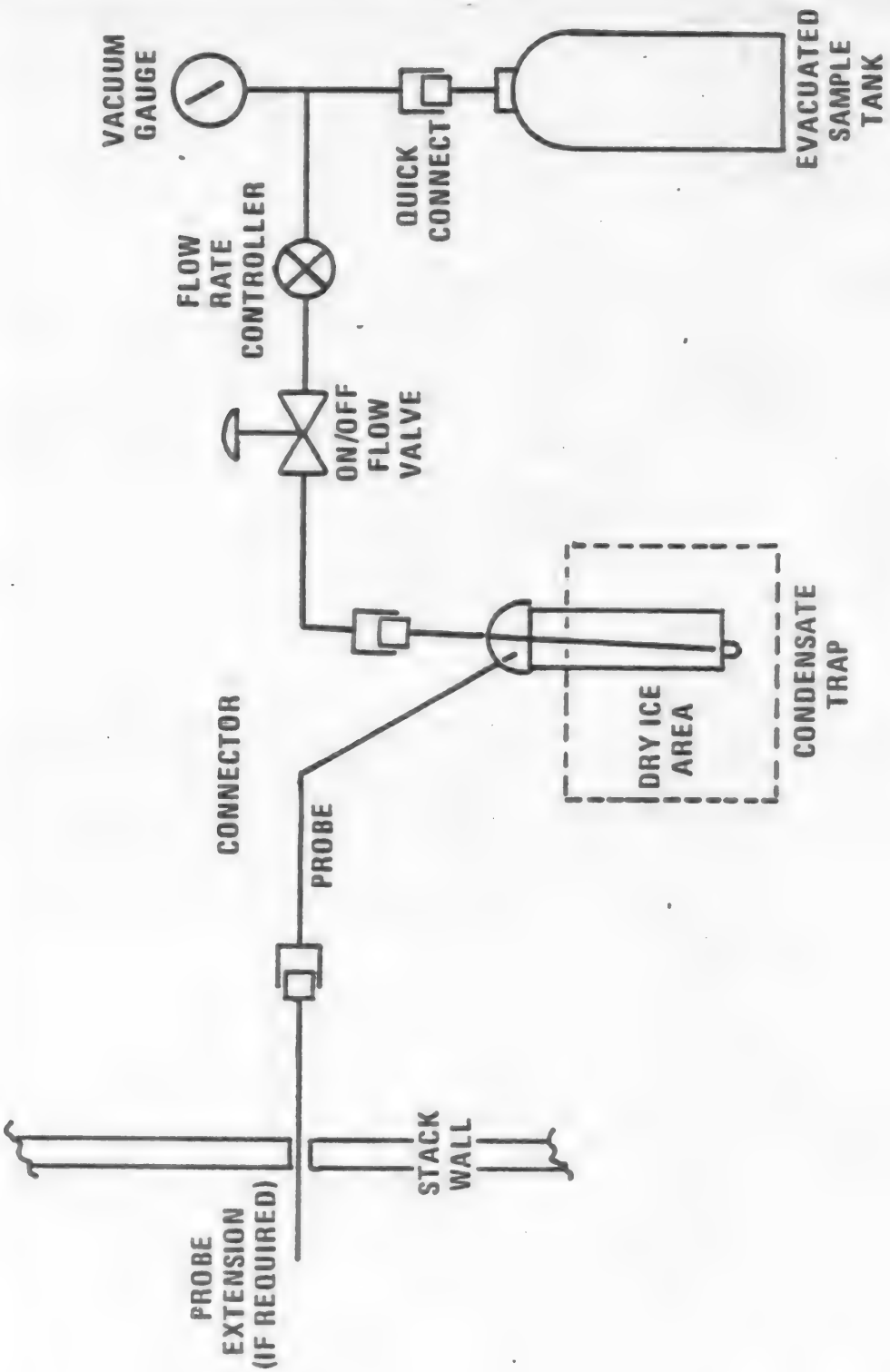

Figure 1. Sampling apparatus.

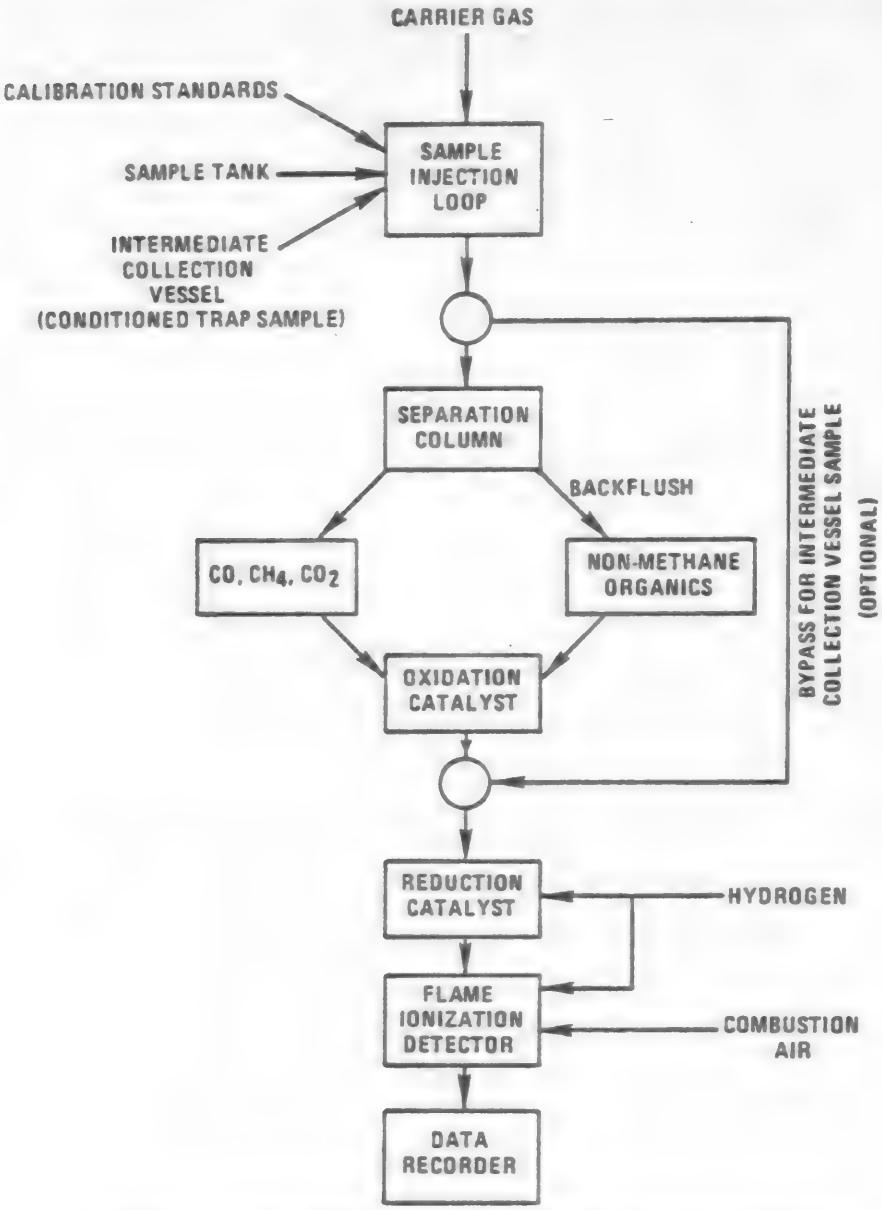

Figure 2. Simplified schematic of total gaseous non-methane organic (TGNMO) analyzer.

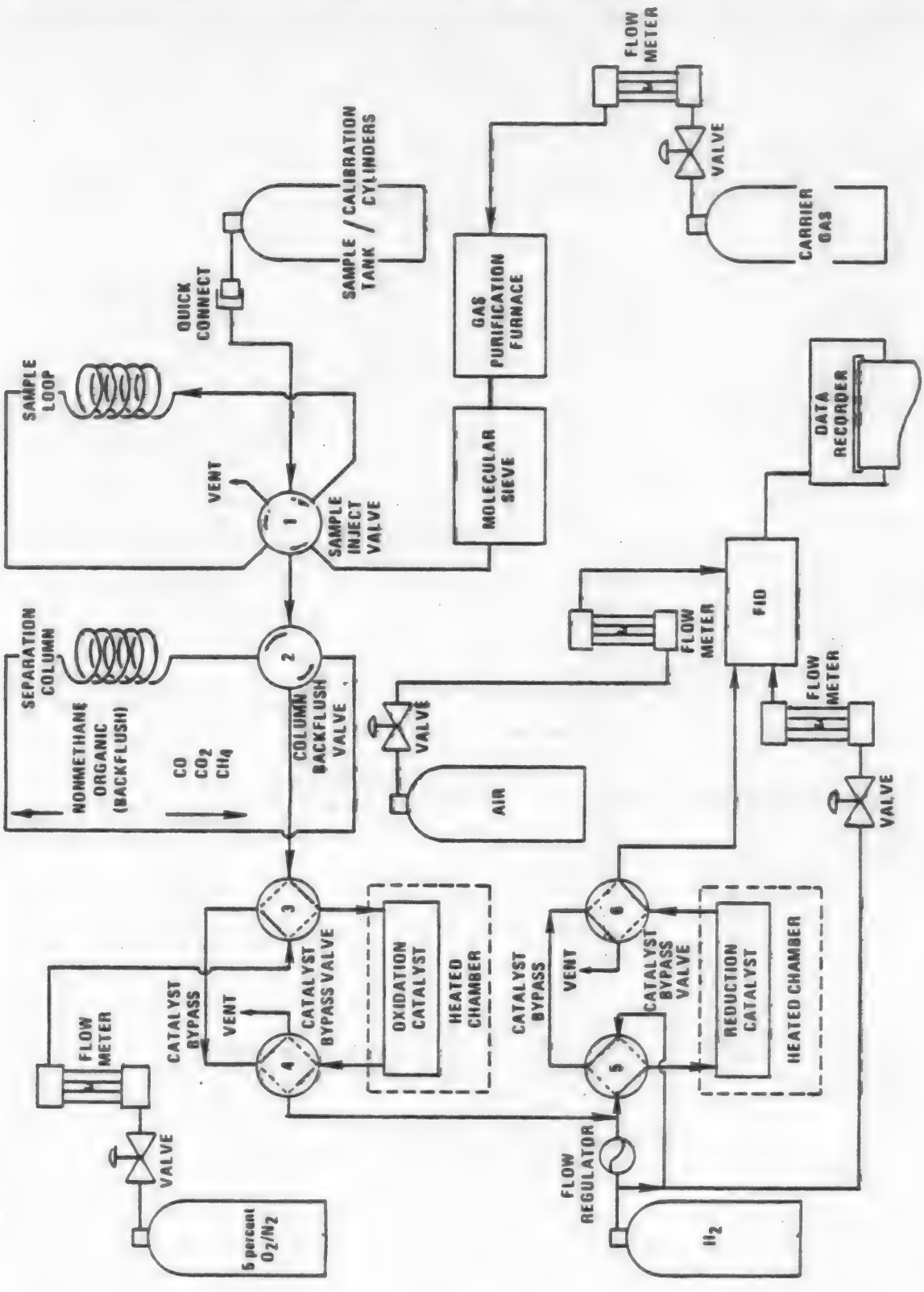

Figure 3. Total gaseous nonmethane organic (TGNMO) analyzer.

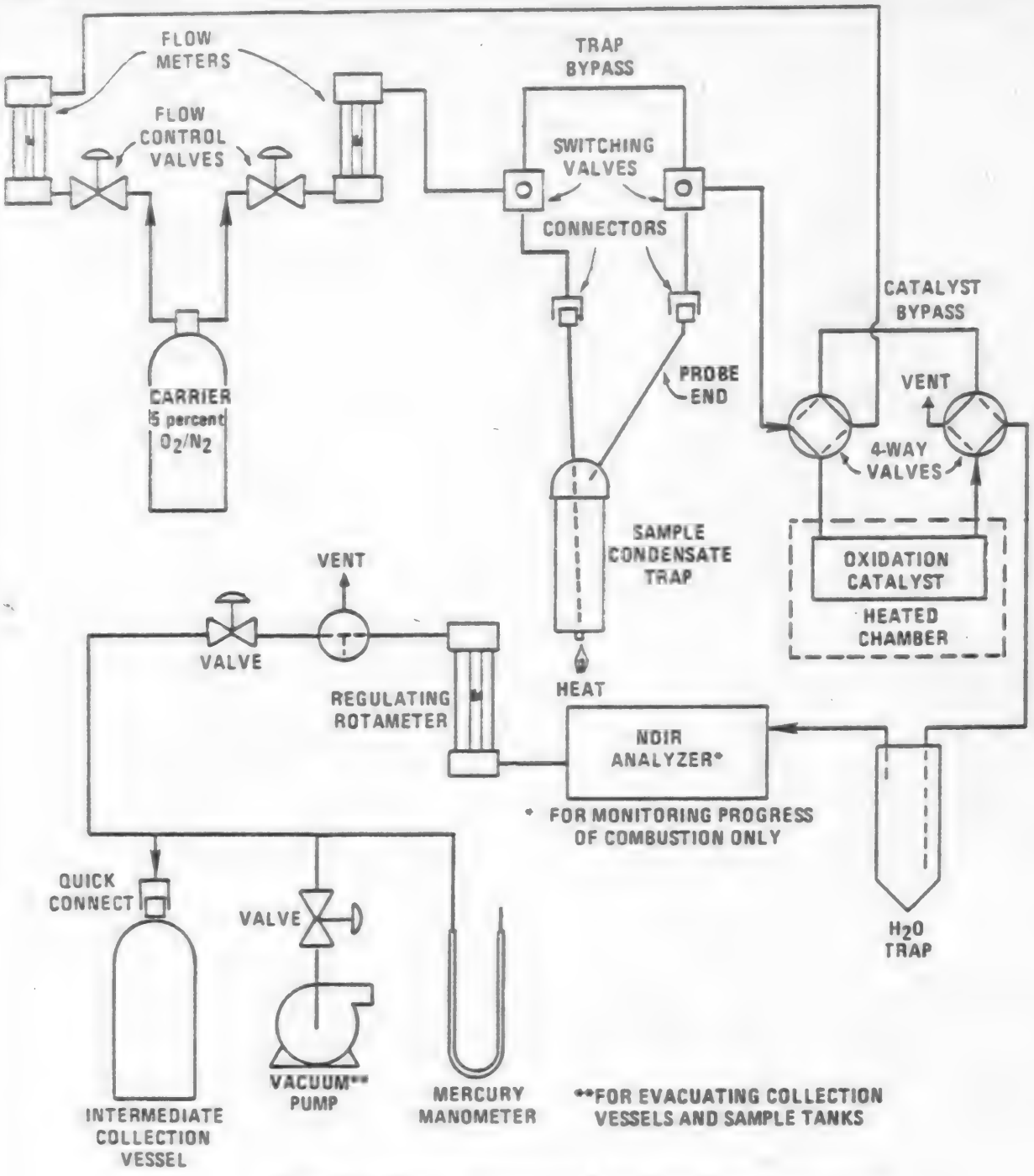

Figure 4. Condensate recovery and conditioning apparatus.

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2.2 Sampling.

2.2.1 Probe. ⅛" stainless steel tubing.

2.2.2 Condensate Trap. The condensate trap shall be constructed of 316 stainless steel; construction details of a suitable trap are shown in Figure 5.

2.2.3 Flow Shut-off Valve. Stainless steel control valve for starting and stopping sample flow.

2.2.4 Flow Control System. Any system capable of maintaining the sampling rate to within ±10 percent of the selected flow rate (50—100 cc/min. range).

2.2.5 Vacuum Gauge. Vacuum gauge calibrated in mm Hg. for monitoring the vacuum of the evacuated sampling tank during leak checks and sampling.

2.2.6 Gas Collection Tank. Stainless steel or aluminum tank with a volume of 4 to 8 liters. The tank is fitted with a stainless steel female quick connect for assembly to the sampling train and analytical system.

2.2.7 Mercury manometer. U-tube mercury manometer capable of measureing pressure to within 1.0 mm Hg in the 0/900 mm range.

2.2.8 Vacuum Pump. Capable of pulling a vacuum of 700 mm Hg.

2.3 Analysis. For analysis, the following equipment is needed.

2.3.1 Condensate Recovery and Conditioning Apparatus (Figure 4).

2.3.1.1 Heat Source. A heat source sufficient to heat the condensate trap to a temperature just below the point where the trap turns a "cherry red" color is required. An electric muffle-type furnace heated to 600° C is recommended.

2.3.1.2 Oxidizing Catalyst. Inconel tubing packed with an oxidizing catalyst capable of meeting the catalyst efficiency criteria of this method (Section 4.4.2).

2.3.1.3 Water Trap. Any leak proof moisture trap capable of removing moisture from the gas stream may be used.

2.3.1.4 NDIR Detector. A detector capable of indicating CO_2 concentration in the zero to 5 percent range. This detector is required for monitoring the progress of combustion of the organic compounds from the condensate trap.

2.3.1.5 Pressure Regulator. Stainless steel needle valve required to maintain the NDIR detector cell at a constant pressure.

2.3.1.6 Intermediate Collection Tank. Stainless steel or aluminum collection vessel. Tanks with nominal volumes in the 1 to 4 liter range are recommended. The end of the tank is fitted with a female quick connect.

2.3.2 Total Gaseous Nonmethane Organic (TGNMO) Analyzer. Semi-continuous GC/FID analyzer capable of: (1) separating CO, CO_2, and CH_4 from nonmethane organic compounds, and (2) oxidizing the non-methane organic compounds to CO_2, reducing the CO_2 to methane, and quantifying the methane. The analyzer shall be demonstrated prior to initial use to be capable of proper separation, oxidation, reduction, and measurement. As a minimum, this demonstration shall include measurement of a known TGNMO concentration present in a mixture that also contains CH_4, CO, and CO_2 (see paragraph 4.4.1).

2.3.2.1 The TGNMO analyzer consists of the following major components.

2.3.2.1.1 Oxidation Catalyst. Inconel tubing packed with an oxidation catalyst capable of meeting the catalyst efficiency criteria of paragraph 4.4.1.2.

2.3.2.1.2 Reduction Catalyst. Inconel tubing packed with a reduction catalyst capable of meeting the catalyst efficiency criteria of paragraph 4.4.1.3.

2.3.2.1.3 Separation Column. A gas chromatographic column capable of separating CO, CO_2, and CH_4 from nonmethane organic compounds. The specified column is as follows: ⅛ inch O.D. stainless steel packed with 3 feet of 10 percent methyl silicone, Sp 2100* (or equivalent) on Supelcoport* (or equivalent), 80/100 mesh, followed by 1.5 feet porapak Q* (or equivalent) 60/80 mesh. The inlet side is to the silicone.

Other columns may be used subject to the approval of the Administrator. In any event, proper separation shall be demonstrated according to the procedures of paragraph 4.4.1.4.

2.3.2.1.4 Sample Injection System. A gas chromatographic sample injection valve with sample loop sized to properly interface with the TGNMO system.

2.3.2.1.5 Flame Ionization Detector (FID). A flame ionization detector meeting the following specifications is required:

2.3.2.1.5.1 Linearity. A linearity of ±5 percent of the expected value for each full scale setting up to the maximum percent absolute (methane or carbon equivalent) calibration point is required. The FID shall be demonstrated prior to initial use to meet this specification through a 5-point (minimum) calibration. There shall be at least one calibration point in each of the following ranges: 5–10, 50–100, 500–1,000, 5,000–10,000, and 40,000–100,000 ppm (methane or carbon equivalent). Certification of such demonstration by the manufacturer is acceptable. An additional linearity performance check (see Section 4.4.1.1) must be made before each use (i.e., before each set of samples is analyzed or daily whichever occurs first).

2.3.2.1.5.2 Range. Signal attenuators shall be available so that a minimum signal response of 10 percent of full scale can be produced when analyzing calibration gas or sample.

2.3.2.1.5.3 Sensitivity. The detector sensitivity shall be equal to or better than 2.0 percent of the full scale setting, with a minimum full scale setting of 10 ppm (methane or carbon equivalent).

2.3.2.1.6 Data Recording System. Analog strip chart recorder or digital integration system for permanently recording the analytical results.

2.3.3 Mercury Manometer. U-tube mercury manometer capable of measuring pressure to within 1.0 mm Hg in the 0–900 mm range.

2.3.4 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm.

2.3.5 Vacuum Pump. Laboratory vacuum pump capable of evacuating the sample tanks to an absolute pressure of 5 mm Hg.

3. Reagents.

3.1 Sampling.

3.1.1 Crushed Dry Ice.

3.2 Analysis.

3.2.1 TGNMO Analyzer.

3.2.1.1 Carrier Gas. Pure helium, containing less than 1 ppm organics.

3.2.1.2 Fuel Gas. Pure Hydrogen, containing less than 1 ppm organics.

3.2.2 Condensate Recovery and Conditioning Apparatus.

3.2.2.1 Carrier Gas. Five percent O_2 in N_2, containing less than 1 ppm organics.

3.3 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder so that the gas concentration does not change more than ±5 percent from its certified value. The date of gas cylinder preparation, certified organic concentration and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer.

3.3.1 TGNMO Analyzer.

3.3.1.1 Oxidation Catalyst Efficiency Check. Gas mixture standard with nominal concentration of 5 percent methane and 5 percent oxygen in nitrogen.

3.3.1.2 Reducation Catalyst Efficiency Check. Gas mixture standard with nominal concentration of 5 percent CO_2 in air.

3.3.1.3 Flame Ionization Detector Linearity Calibration Gases (3). Gas mixture standards with known methane (CH_4) concentrations in the 5–10 ppm, 500–1,000 ppm, and 5–10 percent range, in air. These gas standards are to be used to check the FID linearity as described in Section 4.4.1.1.

3.3.1.4 System Operation Standards (2). These calibration gases are required

*Mention of trade name does not constitute endorsement.

to check the total system operation as specified in Section 4.4.1.4. Two gas mixtures are required:

3.3.1.4.1 Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 2 percent CO_2, and 15 ppm C_3H_8, prepared in air.

3.3.1.4.2 Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 2 percent CO_2, and 1,000 ppm C_3H_8, prepared in air.

3.3.2 Condensate Recovery and Conditioning Apparatus. The calibration gas specified in paragraph 3.3.1.1 is required for performing an oxidation catalyst check according to the procedure of paragraph 4.4.2.

4. *Procedure.*

4.1 Sampling.

4.1.1 Sample Tank Evacuation. Either in the laboratory or in the field, evacuate the sample tank to 5 mm Hg absolute pressure or less (measured by a mercury U-tube manometer). Record the temperature, barometric pressure, and tank vacuum as measured by the manometer.

4.1.2 Sample Tank Leak Check. Leak check the gas sample tank immediately after the tank is evacuated. Once the tank is evacuated, allow the tank to sit for 30 minutes. The tank is acceptable if no change in tank vacuum (measured by the mercury manometer) is noted.

4.1.3 Assembly. Just prior to assembly, use a mercury U-tube manometer to measure the tank vacuum. Record this vacuum (P_{ti}), the ambient temperature (T_{ti}), and the barometric pressure (P_{bi}) at this time. Assuring that the flow control valve is in the closed position, assemble the sampling system as shown in Figure 1. Immerse the condensate trap body in dry ice to within 1 or 2 inches of the point where the inlet tube joins the trap body.

4.1.4 Leak Check Procedures.

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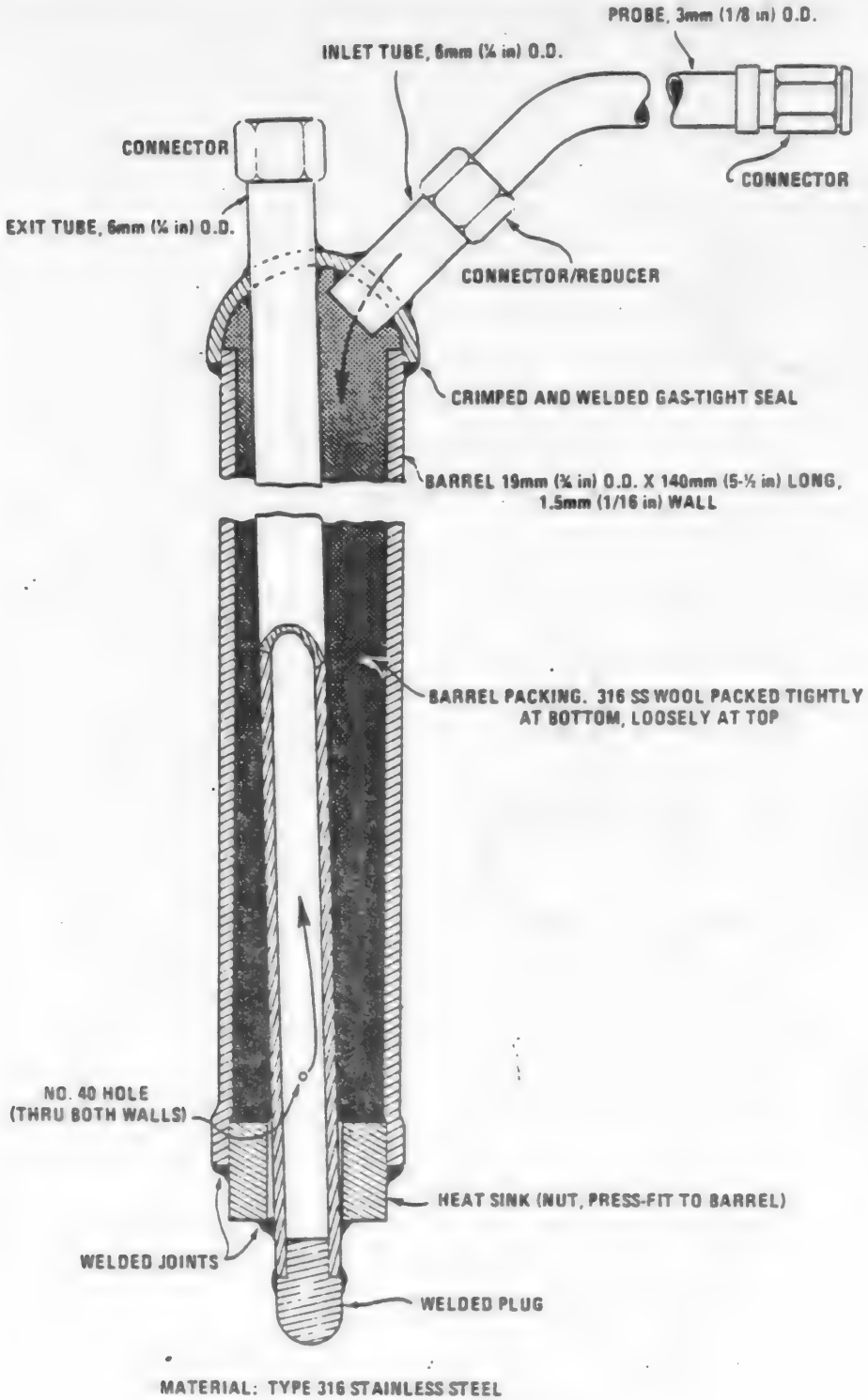
PROBE, 3mm (1/8 in) O.D.
INLET TUBE, 6mm (¼ in) O.D.
CONNECTOR
CONNECTOR
EXIT TUBE, 6mm (¼ in) O.D.
CONNECTOR/REDUCER
CRIMPED AND WELDED GAS-TIGHT SEAL
BARREL 19mm (¾ in) O.D. X 140mm (5-½ in) LONG, 1.5mm (1/16 in) WALL
BARREL PACKING. 316 SS WOOL PACKED TIGHTLY AT BOTTOM, LOOSELY AT TOP
NO. 40 HOLE (THRU BOTH WALLS)
HEAT SINK (NUT, PRESS-FIT TO BARREL)
WELDED JOINTS
WELDED PLUG
MATERIAL: TYPE 316 STAINLESS STEEL

Figure 5. Condensate trap[2].

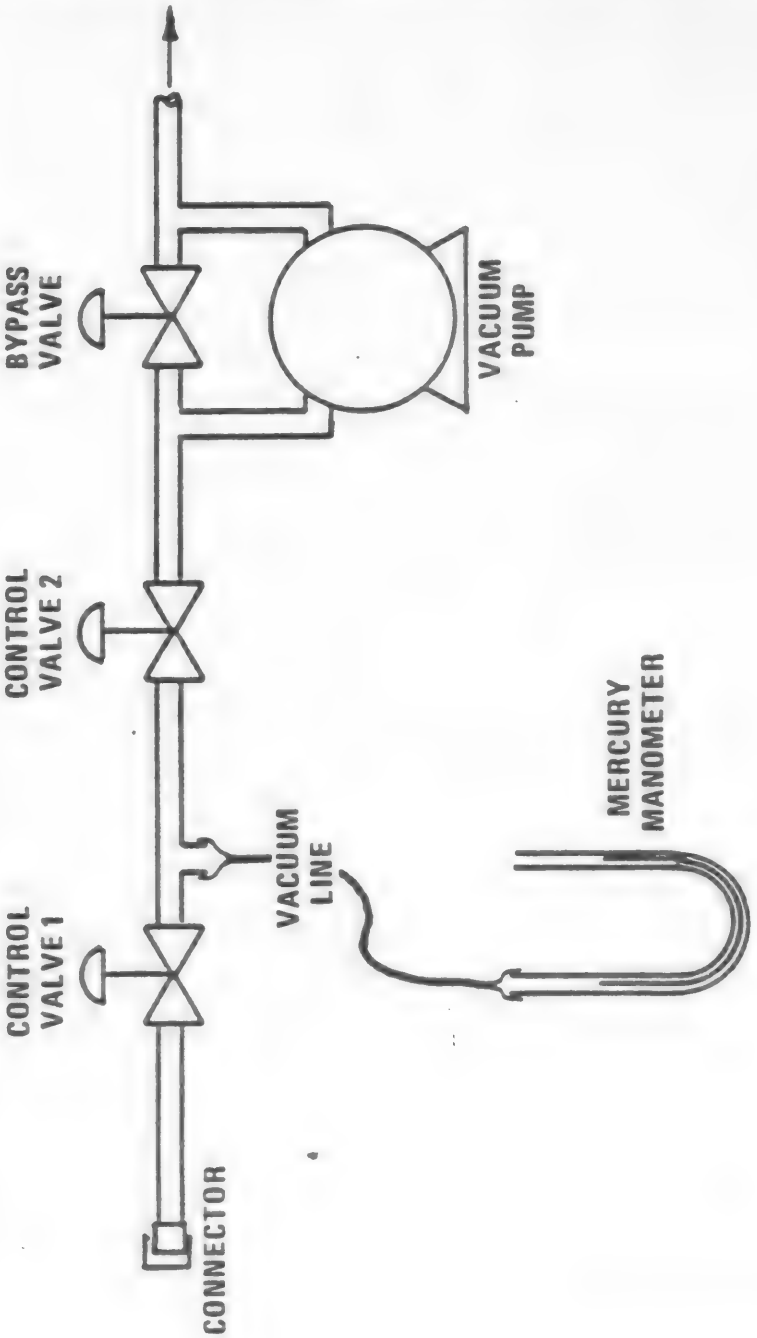

Figure 6. Leak check apparatus.

VOLATILE ORGANIC CARBON

FACILITY _____ SAMPLE LOCATION _____

LOCATION _____ OPERATOR _____

DATE _____ RUN NUMBER _____

TANK NUMBER _____ TRAP NUMBER _____ SAMPLE ID NUMBER _____

	TANK VACUUM, mm Hg		BAROMETRIC PRESSURE, mm Hg	AMBIENT TEMPERATURE, °C
PRETEST (MANOMETER)	_____	(GAUGE) _____	_____	_____
POST TEST (MANOMETER)	_____	(GAUGE) _____	_____	_____

LEAK RATE, mm Hg/5 min.:	TANK	TRAP HALF
PRETEST	_____	_____
POST TEST	_____	_____

TIME CLOCK/SAMPLE	GAUGE VACUUM, mm Hg	FLOWMETER SETTING	COMMENTS

Figure 7. Example Field Data Form.

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4.1.4.1 Pretest Leak Check. A pretest leak check is required. After the sampling train is assembled, record the tank vacuum as indicated by the vacuum gauge. Wait a minimum period of 15 minutes and recheck the indicated vacuum. If the vacuum has not changed, the portion of the sampling train behind the shut-off valve does not leak and is considered acceptable. To check the front portion of the sampling train, attach the leak check apparatus (Figure 6) to the probe tip. Evacuate the front half of the train (i.e., do not open the sampling train flow control valve) to a vacuum of at least 500 mm Hg. Close the shut-off valve on the leak check apparatus and record the vacuum indicated by the manometer on the data sheet (Figure 7). Allow the system to sit for 5 minutes and then recheck the vacuum. A change of less than 2 mm Hg for the 5-minute leak check period is acceptable. Record the front half leak rate (mm Hg/5-minute period) on the data form. When an acceptable leak rate has been obtained disconnect the leak check apparatus from the probe tip.

4.1.4.2 Post Test Leak Check. A leak check is mandatory at the conclusion of each test run. After sampling is completed, attach the U-tube manometer to the probe tip; minimize the amount of flexible line used. Open the sample train flow control valve for a period of 2 minutes or until the vacuum indicated on the manometer stabilizes, whichever occurs first; shut off the sample train flow control valve. Record the vacuums indicated on the manometer (front half) and on the tank vacuum gauge (back-half). After 5 minutes, recheck these vacuum readings. A leak rate of less than 2 mm Hg per 5-minute period is acceptable for the front half; the back half portion is acceptable if no visible change in the tank vacuum gauge occurs. Record the post test leak rate (mm Hg per 5 minutes), and then disconnect the manometer from the probe tip and seal the probe. If the sampling train does not pass the post test leak check, invalidate the run.

4.1.5 Sample Train Operation. Place the probe into the stack such that the probe is perpendicular to the direction of stack gas flow; locate the probe tip at a single preselected point. For stacks having a negative static pressure, assure that the sample port is sufficiently sealed to prevent air in-leakage around the probe. Check the dry ice level and add ice if necessary. Record the clock time and sample tank gauge vacuum. To begin sampling, open and adjust (if applicable) the flow control valve(s) of the flow control system utilized in the sampling train; maintain a constant flow rate (± 10 percent) throughout the duration of the sampling period. Record the gauge vacuum and flowmeter setting (if applicable) at 5-minute intervals. Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulation; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained. When the sampling is completed, close the gas sampling tank control valve. Record the final readings. Note: If the sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After removing the probe from the stack, remove the evacuated tank from the sampling train (without disconnecting other portions of the sampling train) and connect another evacuated tank to the sampling train. Prior to attaching the new tank to the sampling train, assure that the tank vacuum (measured on-site by the U-tube manometer) has been recorded on the data form and that the tank has been leak-checked (on-site). After the new tank is attached to the sample train, proceed with the sampling; after the required minimum sampling time has been exceeded, end the test.

4.2 Sample Recovery. After sampling is completed, remove the probe from the stack and seal the probe end. Conduct the post test leak check according to the procedures of paragraph 4.1.4.2. After the post test leak check has been conducted, disconnect the condensate trap at the flow metering system. Tightly seal the ends of the condensate trap; keep the trap packed in dry ice until analysis. Remove the flow metering system from the sample tank. Attach the U-tube manometer to the tank (keep length of flexible connecting line to a minimum) and record the final tank vacuum (P_t); record the tank temperature (T_t) and barometric pressure at this time. Disconnect the manometer from the tank. Assure that the test run number is properly identified on the condensate trap and evacuated tank(s).

4.3 Analysis.

4.3.1 Preparation.

4.3.1.1 TGNMO Analyzer. Set the carrier gas, air, and fuel flow rates and then begin heating the catalysts to their operating temperatures. Conduct the calibration linearity check required in paragraph 4.4.1.1 and the system operation check required in paragraph 4.4.1.4. Optional: Conduct the catalyst performance checks required in paragraphs 4.4.1.2 and 4.4.1.3 prior to analyzing the test samples.

4.3.1.2 Condensate Recovery and Conditioning Apparatus. Set the carrier gas flow rate and begin heating the catalyst to its operating temperature. Conduct the catalyst performance check required in paragraph 4.4.2 prior to oxidizing any samples.

4.3.2 Condensate Trap Carbon Dioxide Purge and Evacuated Sample Tank Pressurization. The first step in analysis is to purge the condensate trap of any CO_2 which it may contain and to simultaneously pressurize the gas sample tank. This is accomplished as follows: Obtain both the sample tank and condensate trap from the test run to be analyzed. Set up the condensate recovery and conditioning apparatus so that the carrier flow bypasses the condensate trap hook-up terminals, bypasses the oxidation catalyst, and is vented to the atmosphere. Next, attach the condensate trap to the apparatus and pack the trap in dry ice. Assure that the valve isolating the collection vessel connection from the atmospheric vent is closed and then attach the gas sample tank to the system as if it were the intermediate collection vessel. Record the tank vacuum on the laboratory data form. Assure that the NDIR analyzer indicates a zero output level and then switch the carrier flow through the condensate trap; immediately switch the carrier flow from vent to collect and open the valve to the tank. The condensate trap recovery and conditioning apparatus should now be set up as indicated in Figure 8. Monitor the NDIR; when CO_2 is no longer being passed through the system, switch the carrier flow so that it once again bypasses the condensate trap. Continue in this manner until the gas sample tank is pressurized to a nominal gauge pressure of 800 mm mercury. At this time, isolate the tank, vent the carrier flow, and record the sample tank pressure (P_{tf}), barometric pressure (P_{bf}), and ambient temperature (T_a). Remove the gas sample tank from the system.

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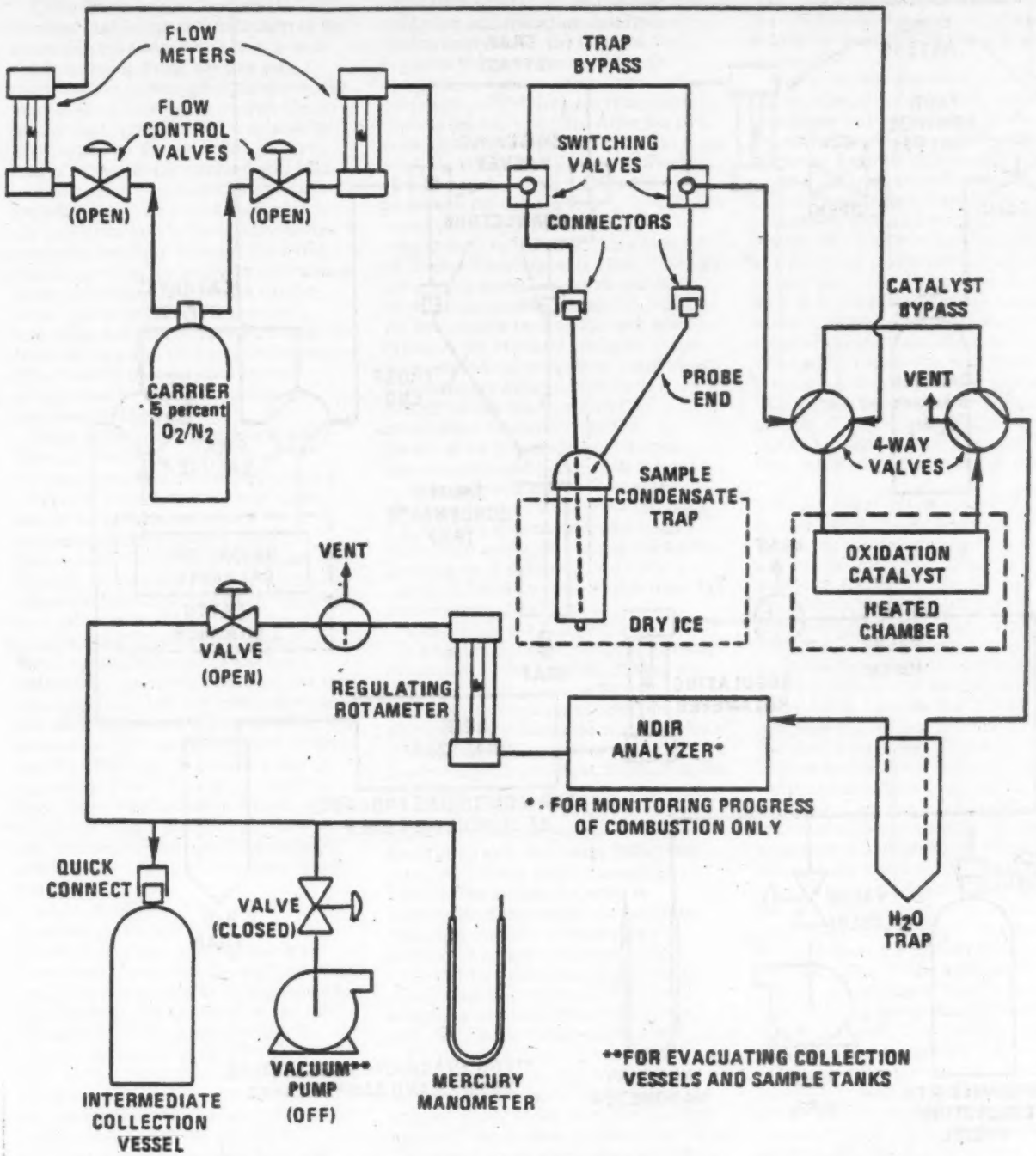

Figure 8. Condensate recovery and conditioning apparatus, carbon dioxide purge.

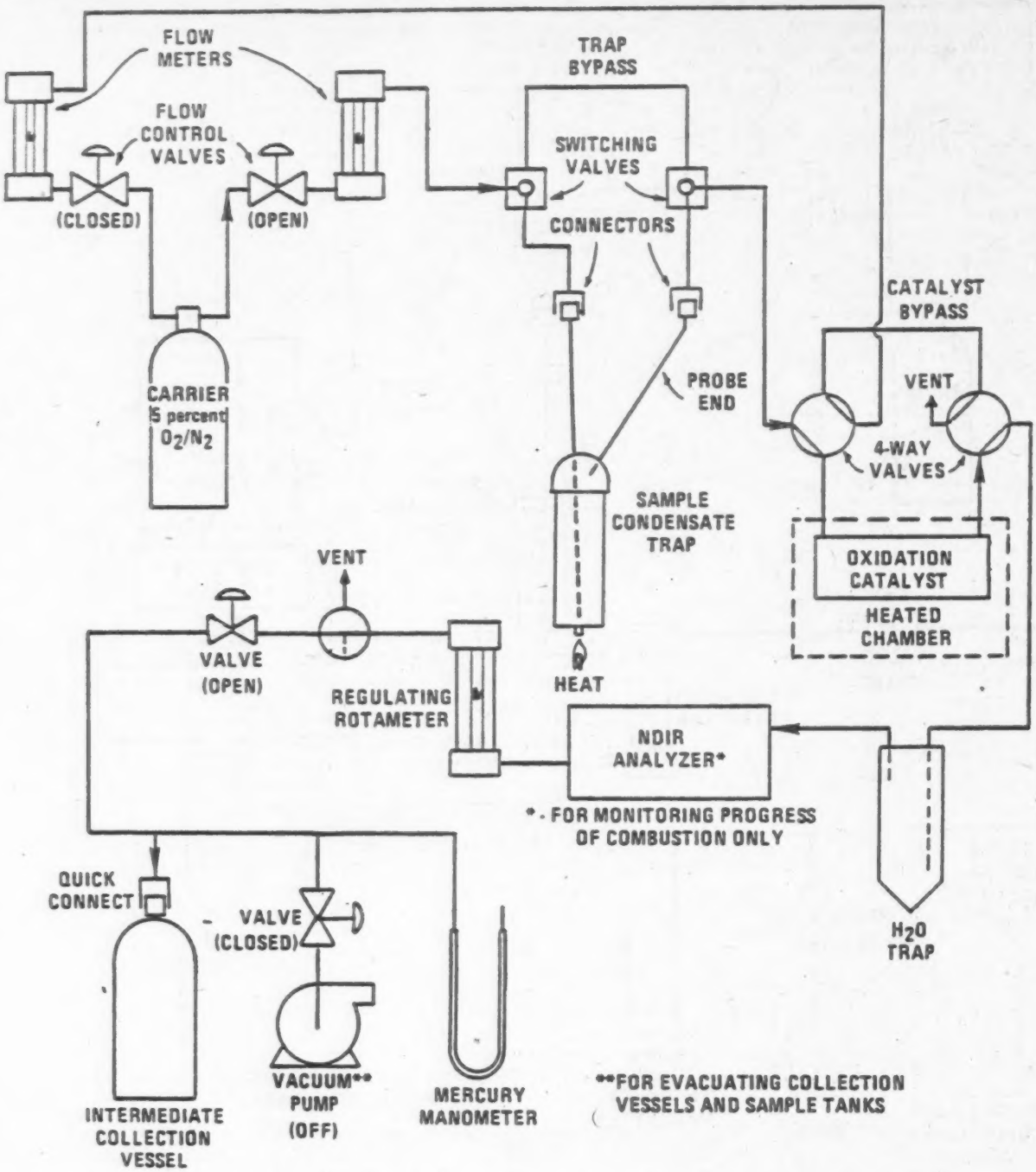

Figure 9. Condensate recovery and conditioning apparatus, collection of trap organics.

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4.3.3 Recovery of Condensate Trap Sample. Oxidation and collection of the sample in the condensate trap is now ready to begin. From the step just completed in paragraph 4.3.2 above, the system should be set up so that the carrier flow bypasses the condensate trap, bypasses the oxidation catalyst, and is vented to the atmosphere. Attach an evacuated intermediate collection vessel to the system and then, switch the carrier so that it flows through the oxidation catalyst. Monitor the NDIR and assure that the analyzer indicates a zero output level. Switch the carrier from vent to collect and open the collection tank valve; remove the dry ice from the trap and then switch the carrier flow through the trap. The system should now be set up to operate as indicated in Figure 9.

Begin heating the condensate trap. The trap should be heated to a temperature at which the trap glows a "dull red" (approximately 600° C) and should be maintained at this temperature for at least 5 minutes. During oxidation of the condensate trap sample, monitor the NDIR to determine when all the sample has been removed and oxidized (indicated by return to baseline of NDIR analyzer output). When complete recovery has been indicated, remove the heat from the trap. However, continue the carrier flow until the intermediate collection vessel is pressurized to a gauge pressure of 800 mm Hg (nominal). When the vessel is pressurized, vent the carrier; measure and record the final intermediate collection vessel pressure (P_f) as well as the barometric pressure (P_{bv}), ambient temperature (T_v), and collection vessel volume (V_v).

4.3.4 Analysis of Recovered Condensate Sample. After the preparation steps in paragraph 4.3.1 have been completed, the analyzer is ready for conducting analyses. Assure that the analyzer system is set so that the carrier gas is routed through the reduction catalyst to the FID (flow through the separation column and oxidation catalyst is optional). Attach the intermediate collection vessel to the tank inlet fitting of the TGNMO analyzer. Purge the sample loop with sample and then inject a preliminary sample in order to determine the appropriate FID attenuation. Inject triplicate samples from the intermediate collection vessel and record the values (C_{cm}). When appropriate, check the instrument calibration according to the procedures of paragraph 4.4.1.4.

4.3.5 Analysis of Gas Sample Tank. Assure that the analyzer is set up so that the carrier flow is routed through the separation column as well as both the oxidation and reduction catalysts. During analysis for the nonmethane organics the separation column is operated as follows: First, operate the column at −78° C (dry ice temperature) to elute the CO and CH_4. After the CH_4 peak, operate the column at 0° C to elute the CO_2. When the CO_2 is completely eluted, switch the carrier flow to backflush the column and simultaneously raise the column temperature to 100° C in order to elute all nonmethane organics. (Exact timings for column operation are determined from the calibration standard). Attach the gas sample tank to the tank inlet fitting of the TGNMO analyzer. Purge the sample loop with sample and inject a preliminary sample in order to determine the appropriate FID attenuation for monitoring the backflushed non-methane organics. Inject triplicate samples from the gas sample tank and record the values obtained for the nonmethane organics (C_{tm}). When appropriate, check the instrument calibration according to the procedures of paragraph 4.4.1.4.

4.4 Calibration. Maintain a record of performance of each item.

4.4.1 TGNMO Analyzer.

4.4.1.1 FID Calibration and linearity check. Set up the TGNMO system so that the carrier gas bypasses the oxidation and reduction catalysts. Zero and span the FID by injecting samples of the high value (5–10 percent) calibration gas (paragraph 3.3.1.3) and adjusting the instrument output to the correct level. Then check the instrument linearity by injecting triplicate samples of the low (5–10 ppm) and mid-range (500–1,000 ppm) calibration gases (paragraph 3.3.1.3). The system linearity is acceptable if the results (average for triplicate samples of each gas) are within ±5 percent of the expected values. This calibration and linearity check shall be conducted prior to analyzing each set of samples (i.e., samples from a given source test).

4.4.1.2 Oxidation Catalyst Efficiency Check. This check should be performed on a frequency established by the amount of use of the analyzer and the nature of the organic emissions to which the catalyst is exposed. As a minimum, perform this check prior to putting the analyzer into service.

To confirm that the oxidation catalyst is functioning in a correct manner, the operator must turn off or bypass the reduction catalyst while operating the analyzer in an otherwise normal fashion. Inject triplicate samples of the methane standard gas (paragraph 3.3.1.1) into the system. If oxidation is adequate, the only gas that will then reach the detector will be CO_2, to which the FID has no response. If a response is noted, the oxidation catalyst must be replaced.

4.4.1.3 Reduction Catalyst Efficiency Check. This check should be performed on a frequency established by the amount of use of the analyzer. As a minimum, perform this check prior to putting the analyzer into service. To confirm proper operation of the reduction catalyst, the operator must bypass the oxidation catalyst while operating the analyzer in an otherwise normal manner. After setting the carrier flow to bypass the oxidation catalyst, inject triplicate samples of the carbon dioxide standard gas (Section 3.3.1.2). The catalyst operation is acceptable if the average response of the triplicate CO_2 sample injections is within ±2 percent of the expected value and no one CO_2 sample injection varies by more than ±5 percent from the expected value.

4.4.1.4 System Operation Check. This system check should be conducted at a frequency consistent with the amount of use and the reliability of the particular analyzer. As a minimum, this system check shall be conducted before and after each set of emission samples is analyzed. If this system check is not successfully completed at the conclusion of the analyses, the results shall be invalidated. Operate the TGNMO analyzer in a normal fashion, passing the carrier flow through the separation column and both the oxidation and reduction catalysts. Inject triplicate samples of the two mixed gas standards specified in Section 3.3.1.4. The system operation is acceptable if, for each gas mixture, the average non-methane organic value for the triplicate samples is within ±3 percent of the expected value and no one sample analysis varies by more than ±5 percent from the average value for the triplicate samples.

4.4.2 Condensate Trap Recovery and Conditioning Apparatus Oxidation Catalyst Check. This catalyst check should be conducted at a frequency consistent with the amount of use of the catalyst, as well as, the nature and concentration level of the organics being recovered by the system. As a minimum, perform this check prior to and immediately after conditioning each set of emission sample traps.

Set up the condensate trap recovery system so that the carrier flow bypasses the trap inlet and is vented to the atmosphere at the system outlet. Assure that the tank collection valve is closed and then attach an evacuated intermediate collection vessel to the system. Connect the methane standard gas cylinder (Section 3.3.1.1) to the

system's condensate trap connector (probe end, figure 4). Adjust the system valving so that the standard gas cylinder acts as the carrier gas; switch off the carrier and use the cylinder of standard gas to supply a gas flow rate equal to the carrier flow normally used during trap sample recovery. Now switch from vent to collect in order to begin collecting a sample. Continue collecting a sample in the normal manner until the intermediate vessel is filled to a nominal pressure of 300 mm Hg. Remove the intermediate vessel from the system and vent the carrier flow to the atmosphere. Switch the valving to return the system to its normal carrier gas and normal operating conditions. Set up the TGNMO analyzer to operate with the oxidation and reduction catalysts bypassed. Inject a sample from the intermediate collection vessel into the analyzer. The operation of the condensate trap recovery system oxidation catalyst is acceptable if oxidation of the standard methane gas was 99.5 percent complete, as indicated by the response of the TGNMO analyzer FID.

4.4.3 Gas Sampling Tank. The volume of the gas sampling tanks used must be determined. Prior to putting each tank in service, determine the tank volume by weighting the tanks empty and then filled with water; weight to the nearest 0.5 gm and record the results.

4.4.4 Intermediate Collection Vessel. The volume of the intermediate collection vessels used to collect CO_2 during the analysis of the condensate traps must be determined. Prior to putting each vessel into service, determine the volume by weighting the vessel empty and then filled with water; weigh to the nearest 0.5 gm and record the results.

5. *Calculations.*

Note. All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge pressure.

5.1 Sample Volume. For each test run, calculate the gas volume sampled:

$$V_s = 0.386\ V\left(\frac{P_t}{T_t}\right)-\left(\frac{P_{t_i}}{T_i}\right)$$

5.2 Noncondensible Organics. For each collection tank, determine the concentration of nonmethane organics (ppm C):

$$C_t = \frac{\frac{P_{tf}}{T_{tf}}}{\frac{P_t}{T_t}-\frac{P_{ti}}{T_{ti}}} \times \frac{1}{r} \times \sum_{j=1}^{r} C_{tm_j}$$

5.3 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C):

$$C_c = 0.386\ \frac{V_v \times P_f}{V_s \times T_f} \times \frac{1}{N} \times \sum_{k=1}^{n} C_{cm_k}$$

5.4 Total Gaseous Nonmethane Organics (TGNMO). To determine the TGNMO concentration for each test run, use the following equation:

$C = C_t + C_c$

Where:

C = Total gaseous nonmethane organic (TGNMO) concentration of the effluent, ppm carbon equivalent.

C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm carbon equivalent.

C_{cm} = Measured concentration (TGNMO analyzer) for the condensate trap (intermediate collection vessel), ppm methane.

C_t = Calculated noncondensible organic concentration of the effluent, ppm carbon equivalent.

C_{tm} = Measured concentration (TGNMO analyzer) for gas collection tank sample, ppm methane.

P_f = Final pressure of intermediate collection vessel, mm Hg., absolute.

P_{ti} = Gas sample tank pressure prior to sampling, mm Hg, absolute.

P_t = Gas sample tank pressure after sampling, but prior to pressurizing, mm Hg, absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg, absolute.

T_f = Final temperature of intermediate collection vessel, °K.

T_{ti} = Gas sample tank temperature prior to sampling, °K.

T_t = Gas sample tank temperature at completion of sampling, °K.

T_{tf} = Gas sample tank temperature after pressurizing, °K.

V = Gas collection tank volume, dscm.

V_v = Intermediate collection tank volume, dscm.

V_s = Gas volume sampled, dscm.

r = Total number of analyzer injections of tank sample during analysis (where j = injection number, 1 . . . r).

n = Total number of analyzer injections of condensible intermediate collection vessel during analysis (where k = injection number, 1 . . . n).

Standard Conditions = Dry, 760 mm Hg, 293°K.

6. *Bibliography.*

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6.2 Albert E. Salo, William L. Oaks, Robert D. MacPhee. "Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control." Presented at the 67th Annual Meeting of the Air Pollution Control Association, Denver, Colorado, Paper No. 74–190, June 9–13, 1974.

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